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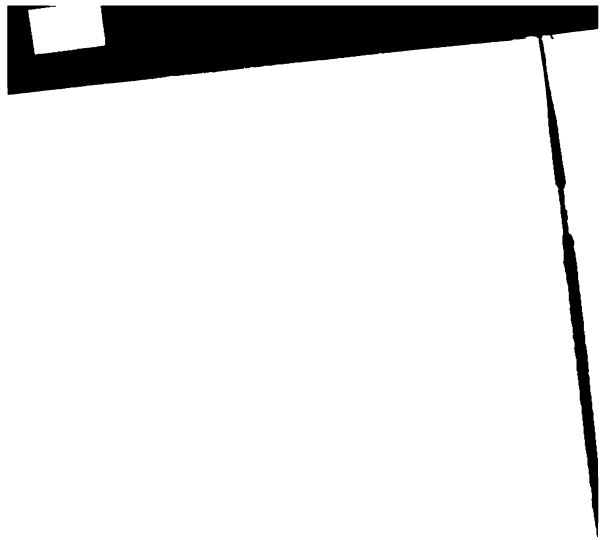

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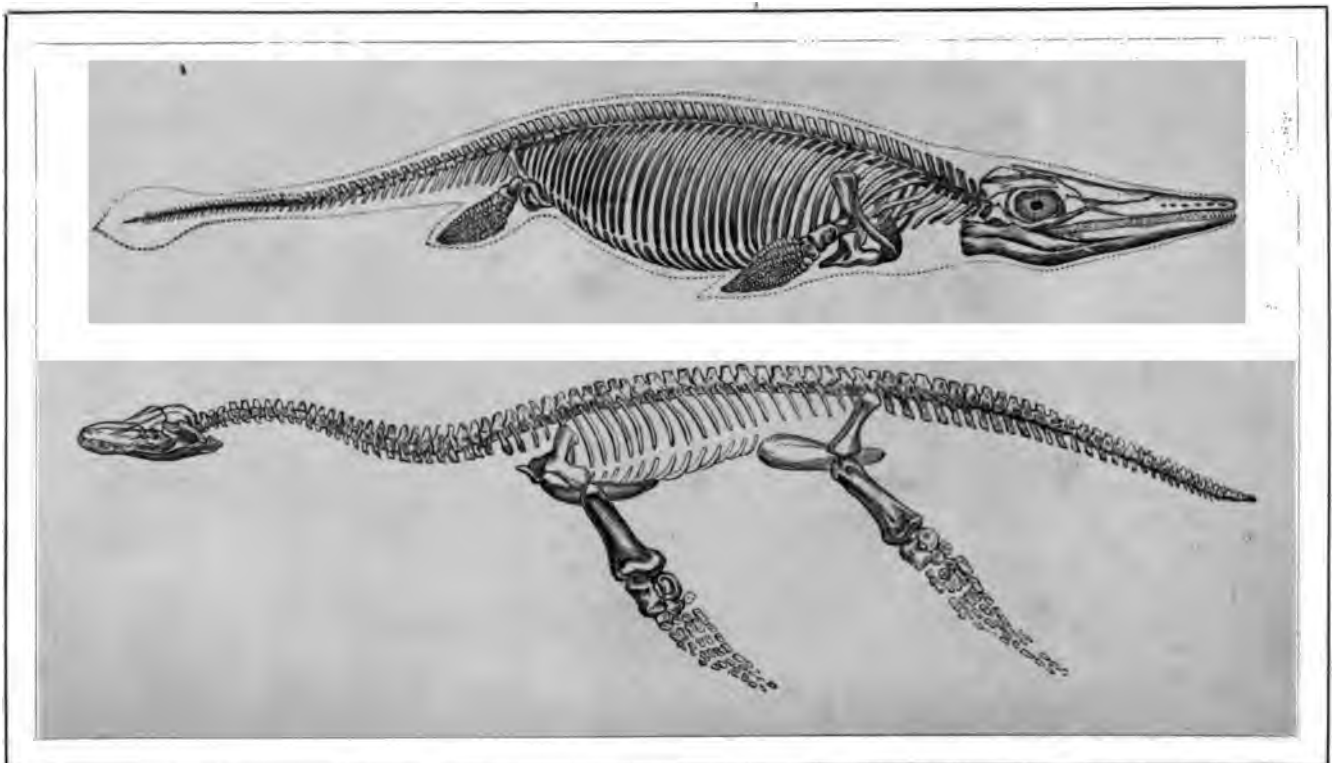

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(*See page* 287.)

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OF

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"Yours sincerely,

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PREFACE

TO THE FIRST EDITION.

I SEND forth this book to the world with mingled feelings of hope and fear—hope that it may, by God's blessing, be useful in suggesting thoughts which will lead to the better appreciation of our much-prized Bible, and fear lest I may have done but imperfect justice to a subject of such great importance.

I cannot sufficiently express my most sincere thanks to the Lord Bishop of London, to Bishop Claughton, to my esteemed vicar, Rev. Gordon Calthrop, M.A., and numerous other friends, for the encouragement they so kindly gave me before many pages were written; the thought of this cheered me on when, perhaps, I should have lost heart at the amount of labour and research necessary for such a work as this.

To the Noblemen and Eminent Men who have also honoured me with their support, I tender my most grateful acknowledgments; and would say that I have felt some solicitude lest the work should not fully realise their anticipations.

From first to last I have enjoyed the privilege of consulting the Rev. Prebendary Reynolds, M.A., late President of Sion College, and Dr. Jabez Hogg, F.R.C.S., F.R.M.S., who have published important works upon similar subjects, and whose advice I have most highly appreciated and invariably acted upon. Through life I shall gratefully remember their kindness.

To the gentlemen who have aided me in revising the proof-sheets, and whom I have mentioned on page 16 in my Introductory Chapter, I desire to express also my warmest thanks; for, occupying as they do such high positions in their various departments of the scientific world, their perusal of the text cannot but inspire confidence in the minds of my readers, and will assure them that the facts brought forward to establish my arguments have been chosen with much care.

I would just refer to my lectures at the British Museum, and at the New Natural History Museum, South Kensington, which, with those delivered to my pupils, form the groundwork of these pages; and I would in my own name, and in the names of my distinguished auditors, acknowledge the attention and courtesy we have always received from Dr. Edward A. Bond, F.R.S., Sir Richard Owen, F.R.S., and Dr. Samuel Birch, whose arrangements have made our afternoon visits to the museums as pleasurable as they have been instructive.

Before closing this Preface, I would not forget my present and past pupils, though many of the latter are now scattered over the world, occupying important positions in distant countries; it may be that this volume will reach them in their far-off homes, and when they read its pages perhaps they may recall the lectures they listened to in their old school days. My sister, Miss Kinns, joins with me in offering them a cordial greeting.

SAMUEL KINNS.

THE COLLEGE,
HIGHBURY NEW PARK,

Christmas-tide, 1881.

SPECIAL PREFACE

TO THE TENTH EDITION.

As it is only five years and nine months since my First Edition was issued from the press, on the 15th of February, 1882, and now a Tenth is being called for, I feel that I have good reason to hope that the Divine blessing has continued to attend my endeavours to remove apparent difficulties and my humble efforts to uphold the inspiration of the Bible.

In all the previous editions I have given, as far as possible, the astronomical and other facts up to the date of going to press. In my First Edition I mentioned 220 as the then known number of asteroids, and have now to record the 271st, discovered by Dr. Knorre at Berlin, the 13th of October, 1887, so rapidly of late have these minor planets been discovered and their orbits calculated. On page 23 the date of Halley's discovery of "a fourth nebula" ought to have been 1677 instead of 1667.

The geology was a short time since most carefully revised, and the proof-sheets of my chapter upon fossil botany were examined and generally approved by Sir William Dawson, F.R.S., &c., Vice-Chancellor of Montreal University, who is considered the highest authority upon this special subject.

The chemistry contained in some of the early chapters I carefully went over with a Government analyst of very high repute, for a late edition, when we made several improvements, one of which was the substitution of Schweizer's recent analysis of sea-water in the place of Maury's on page 83.

Being frequently asked whether Moses had not acquired much scientific information from the Egyptians, I have added in the Appendix, pp. 477 *et seq.*, an article upon his learning, and have given another upon his education, by Professor Canon Rawlinson, which I think will prove that the information he received from the Egyptians would not have enabled

him to write one line of his cosmogony. These two articles I submitted to the late Dr. Samuel Birch, of the Oriental Department, British Museum, and they both received his approval.

I must here pay a tribute of deep respect to my late friend, who never ceased to take the greatest interest in this work, and who was a profound scholar and a perfect gentleman.

Perhaps I might mention one very pleasant incident amongst many in connection with this book—that of an interview at Claremont with His late Royal Highness the Duke of Albany, who, on graciously accepting a copy, favoured me with a long conversation upon the subject-matter of its pages.

In the autumn of 1883 it was suggested by some of my friends that the influence of the work might be extended by my giving a series of lectures throughout England upon the subjects treated of in its pages, and a Committee was formed to carry out such an undertaking, of which the late Lord Shaftesbury* was an earnest and efficient member, and the President was my late much-valued friend, Bishop Piers Claughton.

The present members of this Committee are the Lord Chancellor (*Lord Halsbury*); the Bishops of Winchester, Bath and Wells, and Lichfield; the Deans of Canterbury, Lichfield, and Ripon; the late Lord Mayor (*Sir Robert Fowler, Bart., M.P.*); Sir Thomas Chambers, M.P. (*Recorder of London*); Sir Arthur John Otway, Bart., M.P. (*late Chairman of Committees of Ways and Means*); Ald. Sir William McArthur, M.P.; Wm. McCullagh Torrens, Esq., M.P.; the Rev. Canons Fraser, Hitchcock, and Lefroy; Rev. Henry White (*Chaplain in Ordinary to the Queen*); Rev. Gordon Calthrop, M.A.; Rev. Robert J. Simpson, M.A.; Rev. Edward Alexr. Stuart, M.A.; Rev. Sholto D. Campbell Douglas, M.A.; Dr. Bowman, F.R.S.E., F.R.A.S., F.L.S., F.G.S., F.C.S.; Rabbi Ascher; Dr. Jabez Hogg, F.R.M.S., M.R.C.S., &c.; Captain George Armstrong, R.N.; Henry Robert Lumley,

* See page xxiv.

Esq.; John Derby Allcroft, Esq., J.P.; Joseph Langton, Esq., and other gentlemen.

As to the work already done: the opening lecture was given in the Library of Canterbury Cathedral, followed by others at Exeter Hall, at the Palace of the Bishop of Bath and Wells, at the Deanery of Ripon, at Leeds, Halifax, Derby, Rhyl, Swansea, Torquay, Birkenhead, Rock Ferry, and other places; also in the drawing-rooms of Lord Shaftesbury, Lady Radstock, the Honourable Mrs. Noel, Mrs. Henry Lee, Mrs. John Cartland, Mrs. M. Carter, the Rev. Francis Paynter, M.A. (Rector of Stoke-next-Guildford), General Hankin, C.B., the Mayor of Guildford (William Swayne, Esq., J.P.), &c. &c. A large number of other lectures have been given, and amongst them six Lent-lectures on "The Historical Accuracy of the Bible," at All Souls Church, Langham Place.

The lecture at Canterbury gave rise to a public correspondence, which was concluded by the following letters from the eminent scientists,* who have given me their valuable support from the very first, being published in *The Times*, *The Globe*, and a number of other London and provincial journals:—

LONDON, *June 6th*, 1884.

To the Editor of THE GLOBE, *&c. &c.*

SIR,

In reference to the correspondence which appeared some few months ago as to Dr. Kinns' work, "Moses and Geology," we trust we may count upon your giving insertion to the accompanying letters which have been called forth by the publication of the Seventh Edition, and bear important testimony to the accuracy of the statement of scientific and other facts in the work.

We may add that the cordial reception of the lectures and addresses which Dr. Kinns has continued to give in various towns throughout England, bears witness to the esteem in which he is held.

On behalf of the Committee, we are, Sir, very truly yours,

SHAFTESBURY.
R. N. FOWLER, Lord Mayor.
THOMAS CHAMBERS, Recorder.
R. PAYNE SMITH, Dean of Canterbury.
HENRY WHITE, Chaplain in Ordinary to the Queen.
&c. &c. &c.

* See page 16.

BRITISH MUSEUM, LONDON,
April 12*th*, 1884.

DEAR DR. KINNS,

Having examined the proof-sheets of the Seventh Edition of "Moses and Geology," now in the press, we consider the intrinsic merits of the work as very great, and that you have compiled the scientific, historical, and other facts with much care and accuracy.

Trusting that the book may continue to have the success which it deserves so well, we remain, yours most truly,

S. BIRCH, LL.D.,
THEO. G. PINCHES,
Department of Oriental Antiquities, British Museum.

ROYAL ASTRONOMICAL SOCIETY,
BURLINGTON HOUSE, PICCADILLY,
May 12*th*, 1884.

DEAR DR. KINNS,

At your request I have examined the astronomical portions of "Moses and Geology" for a Seventh Edition of the work. Great credit is, I think, due to you for the care, diligence, and accuracy with which you have brought the scientific information *up to date*, as well as for the thorough revision which the book has now again undergone, rendering it still more worthy of the perusal of those who take an interest in its important subject.

Yours sincerely,
W. T. LYNN, B.A., F.R.A.S.,
Late Superintendent of the Calculating Department, Royal Observatory, Greenwich, and Author of "*Celestial Motions*."

ATHENÆUM CLUB, PALL MALL, S.W.,
21*st May*, 1884.

MY DEAR DR. KINNS,

Having examined the proof-sheets of the geological portion of the Seventh Edition of your work, "Moses and Geology," I can testify to your having exercised great care and pains in the arrangement and statement of the *facts* which they contain.

With kind regards and good wishes, believe me, dear Dr. Kinns, yours truly,

H. W. BRISTOW, F.R.S.,
Senior Director of H.M. Geological Survey.

1, BEDFORD SQUARE, W.C.,
May 14*th*, 1884.

MY DEAR DR. KINNS,

Having gone over the proof-sheets of the Seventh Edition of your book, "Moses and Geology"—or, rather, that portion of it

devoted to the subject with which I am more familiar, the brain and its wondrous nervous connections—I may say your descriptive matter is all that I can desire it to be, lending a charm and a value to the generally instructive character of your work.

Believe me to remain, yours very sincerely,

JABEZ HOGG, M.R.C.S.,
Consulting Surgeon to the Royal Westminster Ophthalmic Hospital,
Fellow of the Medical Society, London, &c.

97, HIGHBURY NEW PARK,
May 15*th*, 1884.

MY DEAR DR. KINNS,

I have at your request again examined all the Hebrew references in your valuable book, "Moses and Geology," and find them quite correct. I humbly believe that you have done immense good by proving the correctness and authenticity of the sacred records, and, trusting you will meet with that success which your ardour and pious labour truly deserve,

I am, my dear Doctor, yours very sincerely,

B. H. ASCHER,
Late for 41 years Rabbi of the United Synagogue.

There are two more letters which I should not like to omit, as they come from the University which some years ago conferred upon me the title of Doctor of Philosophy; the first is from the Secretary and Justizrath. Dr. Haeckel, whom he mentions, is the well-known naturalist.

[*Translation.*]

JENA, 2*nd May*, 1885.

MOST HONOURED SIR,

The copy of the Seventh Edition of your work, "Moses and Geology," sent for the Library of our University, I have duly received, and have delivered it, with your letter, to His Magnificence the Pro-rector.

I have reason to believe that the University will shortly express its thanks officially for your kind gift. At present I take the liberty of congratulating you on the great success of your work, proved through its reaching already the Seventh Edition.

At the same time, I beg you will excuse me for not having specially acknowledged the receipt of your Sixth Edition. As you had in your letter mentioned Professor Dr. Haeckel, I gave both letter and book to him, as he seemed to take an interest in it. The book was afterwards

delivered by Professor Dr. Haeckel to the Library, and I forgot to give you notice of it. Nevertheless the matter has been arranged according to your wishes.

Most sincerely,

DR. JUR. BÖRNER.

It was very gratifying to receive a few days after the promised letter from the Senate:—

[*Translation.*]

TO DR. PH. SAMUEL KINNS,

SIR,

In acknowledging the receipt of the Seventh Edition of your work, "Moses and Geology," which you presented to the Library of our University, we cannot omit to express, in the name of the University, our sincerest thanks for the valuable gift, and sign with the greatest respect.

JENA, *the 9th May*, 1885.

Prorector and Senate of the Grand-ducal and Ducal Saxon University.

W. MÜLLER,
Prorector.

I have published all these letters thus in full, because I feel that it is a matter of the highest importance to my argument, that the *scientific facts*, as stated, should be implicitly relied upon, both now and when I am gone.

And I have something still further to say of no little importance. A controversy was carried on in *The Nineteenth Century* upon the scientific accuracy of the first chapter of Genesis, by eminent writers, the chief of whom were Mr. Gladstone and Professor Huxley—the latter giving, in the December Number for 1885, the proper sequence of animal life, which will be found entirely to agree with my own sequence, in every edition of this work. The following is Professor Huxley's order, "the oldest being at the bottom":—

Formations. **First known Appearance of**

"EOCENE.—Vertebrate *air*-population (Bats)."

[*Not referred to in this work.*]

'JURASSIC.—Vertebrate *air*-population (Birds and Pterodactyles)."

[*See pages* 276 *et seq. of this work.*]

Formations. First known Appearance of

"MIDDLE PALÆOZOIC.—Vertebrate *land*-population (Amphibia, Reptilia [?])." [*See pages* 304 *and* 325.]

"SILURIAN.—Vertebrate *water*-population (Fishes)." [*See pages* 263 *et seq.*]

"Invertebrate *air* and *land*-population (Flying Insects and Scorpions)." [*See pages* 325 *et seq.*]

"CAMBRIAN.—Invertebrate *water*-population; (much earlier if *Eozoon* be animal)." [*See pages* 241 *et seq.*]

Though Professor Huxley differs widely from me on religious subjects, I entertain for him the highest respect, and consider his unintentional confirmation of the sequence I have given, from the *First Edition* in 1882 to the present, as most valuable to my argument.

In connection with this controversy I received the following autograph letter from the late Prime Minister. Mr. Gladstone had previously expressed to me his interest in this work:—

HAWARDEN CASTLE, CHESTER,

December 19th, 1885.

MY DEAR SIR,

I thank you very much for your letter, and I hope you will find that my argument is in some degree concurrent with your own. I learn with pleasure the Bishop of London's intention, and remain,

Faithfully yours,

W. E. GLADSTONE.

Rev. SAMUEL KINNS, Ph.D.

I should like particularly to mention here that it has been a source of much satisfaction that great statesmen of *opposite* political opinions, and ministers of the Gospel of *every rank and creed*, have given me their hearty support and confidence, as was expressly manifested at our meeting at the Mansion House in October, 1885, presided over by the Lord Mayor (Sir Robert Fowler), and addressed by the Lord Chancellor, the Recorder of London, the Dean of Lichfield, Rev. R. J. Simpson, and the Senior Director of the Geological Survey; the company consisting of a large number of distinguished men representing the religious, scientific, and

political worlds. On that occasion the Lord Chancellor (Lord Halsbury) said:—

"It is indeed a matter of congratulation that Dr. Kinns is able "to show that the Bible and the words of Science have in them "the same inspiration, and it is also deeply interesting to know that "the more such studies are pursued, the more the words of the "Bible are brought into harmony with the facts acquired by scientific "research."

Whilst correcting, on the 1st of October, 1885, the proof-sheets of the Eighth Edition, I heard that that earnest and devout servant of God, and my much-beloved personal friend, Lord Shaftesbury, had passed away.

What a life the good Earl had lived of piety, usefulness, and philanthropy! And tens of thousands shed tears of sorrow on that day, mingled however with the joyful anticipation of meeting him again in "the abodes of the blessed."

In a future edition I may give in the Appendix a short account of my visit to his country house, where I spent a most delightful Christmas and New Year. The invitation from my noble friend was sent me on the occasion of my Third Edition coming out, in 1882, and the note commenced thus:—"Three times three, and one cheer more! for the Third Edition of your work; yea, more, I thank God for the success of this unanswerable defence of His blessed Word."

From first to last he cheered me, encouraged me, and rejoiced with me, in this undertaking. God grant that his prayers for the success of this work may be abundantly answered.

I have issued this Tenth Edition on the Lord Mayor's Day in compliment to His Lordship, Alderman P. De Keyser, who was a subscriber to my First Edition; trusting that the book will continue to merit that public esteem which it has hitherto enjoyed, and that not a few will be induced to accept these proofs of the Divine inspiration of the Bible, and of its being a direct revelation from God to man.

GUILDFORD,

9th November, 1887.

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MOSES AND GEOLOGY.

CHAPTER I.

"Thy Word is Truth."

IN a charming little book from a scientific point of view, one of our most popular physicists has written these words, "To make them square with Science new meanings have been found for the beautiful myths and stories of the Bible."

To this I would propose two amendments: first, by substituting the words *sublime truths* for "beautiful myths;" and, secondly, by so altering and transposing the other portions of the sentence that it should read thus:—*Upon a careful study of the sublime truths and stories of the Bible they will be found to harmonise with Science.*

It will then be my endeavour to support these amendments with such facts and arguments as will, I trust, by God's blessing, convince my readers that the learned Professor's statement is quite untenable. On entering upon this undertaking I cannot, however, help feeling a considerable amount of diffidence lest I should do but imperfect justice to a subject of so much importance.

For not only are there men of mark and eminence in the scientific world whose views are opposite to my own, but there are also not a few who cherish for the Bible such a sincere regard and deep reverence that they look with some amount

of distrust upon any new translation of the original text, or upon any explanations of its teachings other than those which they have held from their childhood upwards.

To such scientific men as are unbelievers in Biblical inspiration let me say, that I honour them greatly for their indefatigable efforts in the study of Nature, and feel that we all owe them a debt of gratitude for their many valuable discoveries; and that not only for the immense benefit such discoveries have been to the world, but also because they have greatly enlarged our views of the extent, the beauty, and the perfection of God's works.

Possibly some of the arguments in this book, however imperfectly brought forward, may succeed in winning over to our side these scientific men, who so well deserve our esteem. I would also trust that those who believe in and love their Bible will, after reading these chapters, find that the study of Nature, instead of weakening, tends greatly to strengthen our faith in the Divine origin of the Scriptures.

When I delivered to my pupils and friends the course of extempore lectures which form the foundation of this work, I had not the slightest idea of ever publishing them, and had only jotted down a few notes to assist my memory in these discourses; I therefore, when requested to put them into print, at first quite shrank from the idea, knowing that it would involve much time and labour. My scholastic duties also occupying the greater part of the day, I could only devote a portion of my time to the compilation of these pages. As this book is the outcome mainly of hours that would otherwise have been devoted to rest, may I hope that my readers will deal gently with any imperfections.

I will here just state that the original intention of the lectures was to excite in my boys and their friends an interest in scientific subjects, and I had not specially in view a defence of Biblical statements. Imperceptibly both subjects

got intertwined, and therefore I have retained to a great extent the same plan, and perhaps I may thereby effect the twofold result.

Let me say, further, that in treating of the various scientific subjects, I have only professed to give a few outlines; and therefore earnestly recommend my readers to study for themselves the best and highest authorities upon each subject, and when perusing the works of the great men who have passed away, carefully to supplement them with the most recent discoveries of eminent living philosophers, who are daily adding to the stores of knowledge investigations and results which are as interesting as they are valuable.

I may, perhaps, be somewhat criticised for digressions, allegories, and anecdotes, which may not appear to have a direct bearing upon the special subjects of the various chapters: as, however, I have found that similar digressions have been pleasing to my audiences, by relieving them from that tension of thought required for following up a scientific argument, I have adopted the same course here, trusting that it may be equally agreeable to my readers.

In quoting from celebrated writers, I have not always put the passages in inverted commas, because I have frequently changed the diction to fit it in with the narrative style I have adopted throughout, but I have made a point of gratefully acknowledging all the authors to whom I am indebted for information and scientific facts. May I add that I shall be not a little pleased to hear from them, or any other scientific men, upon the subject of this work, and I will endeavour in the next edition to make any additions or corrections that may be thought desirable.

One hears so frequently that Science and Revelation are at variance, that it seems to be taken for granted that scientific men are, as a rule, disbelievers in inspiration. I have often, in the course of my lectures, pointed out that this is

indeed a great mistake, and that, though there are some few men of high talent and of deep research who ignore the authenticity of the Scriptures, all philosophers are not of the same school; and I contend that not only are sceptical physicists in the minority, but also that men of the highest eminence in every branch of science have been, and still are, sincere believers.

In astronomy and mathematics, who will ever excel our Newton? Will not his powerful intellect be acknowledged and felt as long as the world stands? And yet a more simple-minded and true-hearted Christian could scarcely be found.

> "Such was thy wisdom, Newton, childlike sage!
> Sagacious reader of the works of God,
> And in His word sagacious."—COWPER.

It is delightful also to see by their works that many of our modern astronomical writers are equally devout.

In geology, that science which above all others was supposed to be antagonistic to the Word of God, we find amongst its eminent students and expounders—Hugh Miller, Dr. Pye Smith, Sir Roderick Murchison, and many such sincere believers.

In chemistry and electricity, who could be a greater man than our Faraday? And, with propriety sometimes called the father of those sciences, was he not also a man of God and of prayer? Sir Humphry Davy, too, whose practical and useful applications of scientific principles have so greatly benefited mankind, has left behind him many choice sayings and essays confirmatory of his faith.

In mechanics we might point to George Stephenson, the brave and noble-minded lad, the hardy, persevering miner, and the immortal engineer, who was as devout as he was liberal; and who, when he settled at Tapton, built for his workpeople a church and a chapel, that they might all have the opportunity of worshipping God according to their consciences.

In animal physiology it is true that there are several very learned men who not only deny the inspiration of the Bible, but also disbelieve in Providence and the efficacy of prayer; yet it would be difficult to enumerate the number of God-fearing naturalists whose works abound in devout aspirations.

We will close this list (which could have been extended almost indefinitely) by referring to Dr. Samuel Johnson, whose profound classical scholarship was accompanied with a most extensive knowledge of science as then known, as his folio Dictionary clearly proves; and yet I do not think that history records a more truly pious man: most thoroughly did he take the Bible for his guide through life, and leaned entirely upon its promises for comfort in the hour of death.

I have a still more interesting fact to notice, that at the time of the meeting of the British Association in 1865 a manifesto was drawn up and signed by 617 scientific men, many of whom are of the highest eminence, in which they declare their belief not only in the truth and authenticity of the Holy Scriptures, but also in their harmony with natural science. This manifesto was printed for the signatories, and the original document deposited in the Bodleian Library at Oxford. So intimately does it bear upon the subject of this work, that I feel I cannot have a better introduction than by giving my readers a copy of such an important and most interesting declaration, which is as follows:—

"We, the undersigned students of the Natural Sciences, desire to express our sincere regret that researches into scientific truth are perverted by some in our own times into occasions for casting doubt upon the truth and authenticity of the Holy Scriptures.

"We conceive that it is impossible for the Word of God as written in the book of Nature, and God's Word written in Holy Scripture, to contradict one another, however much they may appear to differ.

"We are not forgetful that physical science is not complete, but is only in a condition of progress, and that at present our finite reason enables us only to see as through a glass darkly, and we confidently believe that a time will come when the two records will be seen to agree in every particular.

"We cannot but deplore that Natural Science should be looked upon with suspicion by many who do not make a study of it, merely on account of the unadvised manner in which some are placing it in opposition to Holy Writ.

"We believe that it is the duty of every scientific student to investigate Nature simply for the purpose of elucidating truth, and that if he finds that some of his results appear to be in contradiction to the written Word, or rather to his own interpretations of it, which may be erroneous, he should not presumptuously affirm that his own conclusions must be right, and the statements of Scripture wrong. Rather leave the two side by side till it shall please God to allow us to see the manner in which they may be reconciled; and instead of insisting upon the seeming differences between Science and the Scriptures, it would be as well to rest in faith upon the points in which they agree."

Here follow the names, which I have given in full in the Appendix, for I consider the united testimony of these gentlemen of inestimable value to the cause I am advocating, and personally I feel honoured by their names being attached to this work, for it will be seen how eminent in the scientific world are those who thus declared themselves believers in Biblical inspiration. In Sir David Brewster's case no less than eleven lines are occupied with his literary and scientific titles.

After this I think we shall not again hear that scientific men are generally infidels, nor that the study of Nature conduces to scepticism; rather let us hope that the time is not far off when every Christian will feel it an imperative duty to acquire a knowledge of those wondrous laws which govern the Universe, and equally admire the composition and properties of a minute grain of sand, as well as those of a

magnificent sun; the structure of a tiny flower, or a forest king; the life and habits of a monad, or those of a sea-monster.

When geologists first stated that the world had existed much longer than 6,000 years, some theologians took fright, and, like the narrow-minded monks of old, who imprisoned Galileo for saying that the earth moves round the sun, they were almost inclined to punish the propagators of these new theories as direful heretics. As time passed on, it was found that by taking the word "day" (יוֹם *yôm*) to signify indefinite periods of time, many serious difficulties were removed.*

I will then endeavour to prove to you that such is doubtless the meaning of this word in the first chapter of Genesis, and this I will do from Scripture itself. In Gen. ii. 4 we read, "These are the generations of the heavens and of the earth when they were created, in the *day* (יוֹם *yôm*) that the Lord God made the earth and the heavens."

If we are to take the word "day" to mean twenty-four hours, then this verse says that the heavens and the earth were created in one day, and not in six, as stated in the first chapter. But if we are to understand by "day" an indefinite period of time, then the matter is clear enough—namely, that the first account shows a series of steps in creation, and the second statement is a summing-up of the whole of these acts within the entire period occupied by creative processes.

Again, in Deut. ix. 1, Moses says, "Hear, O Israel, thou art to pass over Jordan *this day*," and yet he knew that they would not do so till after his death. In Ps. xcv. 8 we find, "Harden not your heart, as in the provocation, and as in the *day* of temptation in the wilderness." Here the word "day" would mean forty years. The meaning of the

* Fuerst observes in his Lexicon that the word translated "day" only exists in derivative senses, and is used to signify a period. Origen, who lived in the third century after Christ, says in his De Oratione, page 249, "a whole age is a day."

phrase in the fourth commandment I have fully entered into when treating of the Sabbath in a subsequent chapter.

It must be specially noticed in the Biblical statement that the sun was not appointed "to rule over the day and over the night" until the fourth period; how then could each of the three previous periods possibly consist of a day of twenty-four hours before such a division of time existed?

Lastly: if by a day we are to understand from sunset to sunset, as observed by the Jews, then how variable such a day would be in different parts of the world, for at the equator it is twenty-four hours from sunset to sunset, but at the actual Poles it is a whole year from sunset to sunset, for there the sun sets on the 25th of September, rises on the 16th of March, and does not set again until the following 25th of September. (*See* p. 474.)

Admiral Pullen tells me that in 1853, when he and his party were in the Polar regions, they lost sight of the sun about the 7th of November, and it remained too dark to get away from the ship until the 6th of the following February, when they again saw the sun just above the horizon from the top of Beechey Island, 680 feet higher than the sea-level. During this absence of the sun he says that they "saw the heavens at noon brilliantly studded with stars."

In reference to the long period of daylight, he also tells me that when in latitude 74° 42′ 50″ and 91° 54′ 15″ longitude, the sky and all around continued so bright that he had a difficulty in persuading himself that it was bed-time, and tried hard to shut out the light at what should have been midnight. The men also wandered about, waiting for darkness to go to their hammocks, although they were "piped" down to bed again and again.*

This, I think, quite sets the matter at rest both Biblically

* The phrase "the evening and the morning" may simply mean the beginning and the end. We still say, "I was just on the eve of starting."

and scientifically; and, doubtless, the whole may be summed up in the expressive words, "One day is with the Lord as a thousand years, and a thousand years as one day."

Taking, then, the days in the cosmogony of Moses as indefinite periods of time, it remains for us to show that the most recent scientific facts, as well as the strata of the earth, accord exactly with the order given by him; and, if so, it must be admitted beyond all question that he received such accurate information directly from God Himself.

To make this statement more manifest, I would remark that the order of seven events could have been given in no

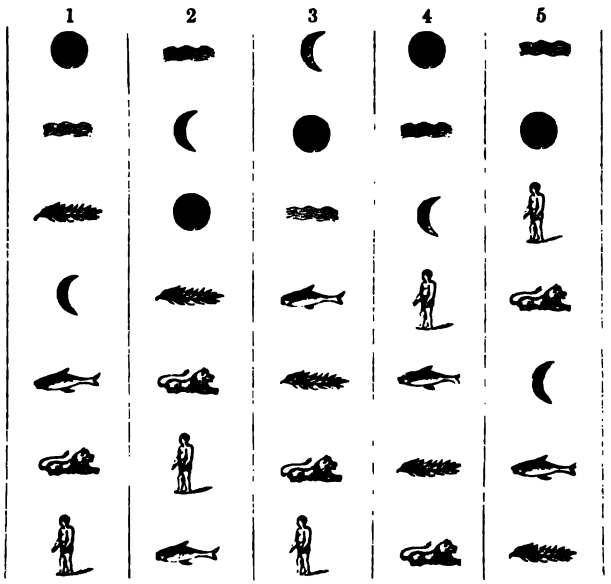


Fig. 1.

less than 5,040 different ways. This, perhaps, will surprise some of my readers who are not much acquainted with the permutations of numbers; but the above diagram (Fig. 1) will explain my meaning. Let the seven small figures stand for any seven creative events, the order of which I have five

times differently arranged in columns. It may seem impossible, nevertheless it is perfectly true, that 5,040 such columns could be made of these seven symbols without two columns being exactly alike.

The possible permutations of any number of things or events may be easily ascertained by multiplying consecutively the figures from 1 upwards, thus—

$$1 \times 2 \times 3 \times 4 = 24, \text{ and } 1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 = 5{,}040.$$

The addition of only one event greatly increases the number of possible variations in the order; for, whilst seven things could be placed in 5,040 different ways, eight could be arranged in 40,320 orders. Perhaps this will be better understood and remembered by a reference to the changes that can be rung upon bells, in which everybody is interested.

When I was collecting information upon the subject I had the good fortune to visit the charming village of Hornchurch in Essex, where I found an old bell-ringer, Joseph Wright, some eighty years of age, who gave me much interesting information on the matter. He had formerly been one of the ringers of the splendid peal of twelve bells in St. Bride's Church, Fleet Street, and on his cottage walls was hanging an account of a special achievement which came off on the 13th of December, 1841, when 5,136 changes were rung by him and his company in three hours and fifty-three minutes; this was called an Oxford treble-bob maximus. Now, as the number of possible changes on twelve bells amounts to 479,001,600, supposing twelve men for 300 days in every year were to repeat this extraordinary achievement, it would take them 300 years to complete all the 479,001,600 changes.

Whilst writing this chapter, and turning over in my mind the best plan to convince my readers of the accuracy of these large numbers, I suddenly remembered being deeply interested some years ago on visiting the manufactory of

Messrs. Hobbs, Hart, and Co., who make the keys to their marvellous locks on this system of permutations, so that no two may be alike. At my first opportunity I called upon them,

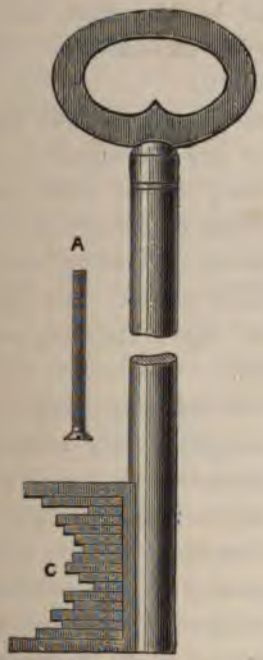


Fig. 2.

Fig. 3.

Fig. 4.

and found them most kind and willing to afford me every possible information, furnishing me also with the accompanying engraving of two keys (Figs. 2 and 3); the smaller one belonging to a lock of nine levers, and the other to one of fifteen levers. By taking out the screw, A, the "movable bits," C, C', can be changed in their order in the smaller key

362,880 times; and the fifteen "bits" of the larger one, which are shown separately in Fig. 4, can be varied in their order

1,307,674,368,000 times.

These figures were furnished me by Mr. Hart, and quite accord with the rule I have just given to find out the number of possible permutations. (*See* p. 479.)

The mechanism of these locks is so wonderful that the levers will adjust themselves to any arrangement of the "movable bits" when *locking them*, but no other arrangement than that special one with which they were locked would unlock them. Hence the chances of their being picked by a false key are more than a *billion to one*. The Bank of England uses the larger lock and key in London, and the smaller one at its country branches.

As the education Moses received in the Egyptian Colleges could not in the least aid him in writing this cosmogony,* and as I have proved to you that the number of changes that can be made in the order of fifteen things is more than a billion, if he has placed *fifteen* important creative events in their proper order without the possibility of traditional help, most of them having happened millions of years before man was created, it is indeed a strong proof of his inspiration, for group such events as you may, the chances must be reckoned by *hundreds of millions* against his giving the order correctly without a special revelation from God.

To fully appreciate this, remember that a clock beating seconds would take over 30,000 years to tick a billion times; so that if any fifteen different events could be written down once in every ten minutes, it would take eighteen millions of years to write all the variations that could be made in their order, writing them day and night without intermission.

I shall then endeavour to show that—

* For the education and learning of Moses, *see* Appendix, pp. 477 *et seq.*

THE FOLLOWING ORDER OF FIFTEEN CREATIVE EVENTS,

AS GIVEN BY MOSES,

CORRESPONDS WITH THAT TAUGHT BY SCIENCE.

I.—MOSES: "*In the beginning God created the Heaven and the Earth.*"

SCIENCE: Astronomical facts go to prove that other worlds were created before our own. It is therefore the right order to mention "The Heaven" first.

"*And the Earth was without form, and void, and darkness was upon the face of the deep.*"

This is doubtless a description of the condition of matter before the creation of the Earth, (p. 20 *et seq.*).

II.—MOSES: "*And God said, Let there be light.*"

SCIENCE: There are strong reasons for believing that, before condensation into their present form, the Sun and Planets existed as a *luminous* nebula (p. 22 *et seq.*).

III.—MOSES: "*And God said, Let there be a firmament.*" (Literally, "an expansion"), p. 65 *et seq.*

SCIENCE: On the cooling of the Earth some of the gases which surrounded it became mechanically and chemically combined to form air and water.

IV.—MOSES: "*And God said, Let the dry land appear.*"

SCIENCE: On further cooling great convulsions took place, which heaved up the rocks and raised them above the universal sea, forming mountains, islands, and continents, (p. 93 *et seq.*).

V.—MOSES: "*And God said, Let the earth bring forth grass.*" The literal translation is: "Let the earth sprout forth sproutage." Notice, seeds are not mentioned.

SCIENCE: The earliest forms of vegetable life were

not grass, but Cryptogams, such as algæ, lichens, ferns, &c., which are propagated by spores and not by seeds. Dawson and Hooker have found such land plants in the Upper Silurian, (p. 141 *et seq.*).

VI.—MOSES: "*The herb yielding seed.*"

SCIENCE: The lowest class of Phænogams, or flowering plants, such as the Conifers, are found in the succeeding strata. Dana mentions coniferous wood being found in the Lower Devonian, (p. 144 *et seq.*).

VII.—MOSES: "*And the fruit tree yielding fruit.*"

SCIENCE: The fossils of a higher class of Phænogams, or flowering plants, bearing a low order of fruit, are found in the Middle Devonian and Carboniferous strata, (p. 156 *et seq.*).

(The higher order of fruit trees appeared later on.)

VIII.—MOSES: "*And God said, Let there be lights in the firmament of heaven, * * and let them be for signs and for seasons, and for days and years.*"

SCIENCE: This does not describe the creation of the Sun and Moon, but their appointment to special offices; for previously to this period there had been no distinct seasons, nor had the days and years been hitherto accurately defined, (p. 186 *et seq.*).

IX.—MOSES: "*And God said, Let the waters bring forth abundantly* (literally, "swarm forth swarms") *the moving* (or *creeping*) *creature that hath life.*"

SCIENCE: This evidently does not refer to the first dawn of animal life, for long before this period all the four great sub-kingdoms had been represented in the sea. But it seems to relate to a great increase in the number of the genera of marine animals, and also to the increase of insects and of reptiles, both of sea and land, (p. 241 *et seq.*).

X.—MOSES: *"And fowl that may fly above the earth."*

SCIENCE: In the New Red Sandstone footprints of birds are found for the first time, (p. 274 *et seq.*).

XI.—MOSES: *"And God created great whales."*
(Should have been translated "sea-monsters.")

SCIENCE: In the succeeding strata of the Lias, monster marine Saurians, such as the Ichthyosaurus and Plesiosaurus, are found, (p. 278 *et seq.*).

XII.—MOSES: *"And God made the beast of the earth after his kind,"* (p. 309 *et seq.*).

SCIENCE: Enormous beasts, such as the Dinotherium, Mastodon, &c., preceded the advent of cattle.

XIII.—MOSES: *"And cattle after their kind,"* (p. 322 *et seq.*).

SCIENCE: Cattle, such as oxen and deer, appeared before man; some of them in the Post-pliocene period.

XIV.—MOSES: *"The Lord God planted a garden . . . and out of the ground made the Lord God to grow every tree that is pleasant to the sight and good for food."*

These passages are from the enlarged story (Gen. ii. 8, 9).

SCIENCE: According to Agassiz, the principal flowers, fruit trees, and cereals appeared only a short time previous to the human race; and we find from Gen. i. 29, that they were existing *"upon the face of all the earth"* when man was created, (p. 335).

XV.—MOSES: *"And God created man in His own image."*

SCIENCE: The highest and last-created form of animal life was Man, (p. 346 *et seq.*).

Finally.—MOSES: *"God ended His work which He had made."*

SCIENCE: As far as our present knowledge goes, no fresh species of plants or animals have appeared upon this Earth since the creation of man, (p. 372).

For Tables of the Order of the Strata of the Rocks, see p. 386 et seq.

To prove that all these events happened in this order, with probable intervals of thousands, and it may have been millions of years between each, is the task I have set myself to do. Should some of the links in the chain of evidence not appear quite perfect to all my readers, they may rest assured that the time will come when the advance of science will remove every difficulty, and make scepticism synonymous with ignorance. For the Word of God *must* prevail.

It has been my aim to give all the scientific facts up to the latest date; and in this I have been aided by the gentlemen referred to in my Preface, to whom I owe the most grateful thanks for perusing the proof-sheets.—Mr. W. Thynne Lynn, B.A., for twenty-five years on the staff of the Royal Observatory, and for some years Superintendent of the Calculating Department, has verified my astronomical facts and figures.—Mr. H. W. Bristow, F.R.S., &c., Senior Director of Her Majesty's Geological Survey, has examined the proofs of my geological chapters.—Dr. Jabez Hogg, F.R.C.S., &c., the Human Physiology.—Mr. Theophilus G. Pinches, of the Department of Oriental Antiquities at the British Museum, the chapter upon Assyrian Tablets and Sculptures. —Mr. Wesley S. B. Woolhouse, F.R.A.S., has verified the calculations in reference to the fifteen events; and Dr. Samuel Birch, F.R.S., Mr. Pinches, and Rev. Dr. Ascher, a learned Jewish Rabbi, have also given me invaluable assistance in reference to the proper translations of the Hebrew words.

Doubtless there are some who will differ from me on scientific and other grounds, but it must not be forgotten that the striking together of flint and steel brings out the sparks of truth. The fact that at a late meeting of the British Association such eminent men as Sir John Lubbock and Prof. Hennessey differed so widely about the internal condition of the Earth, proves beyond all question that even profound philosophers do not always agree.

After reading this chapter it may be that the merchant, when he is locking up his safe, will glance at his beautifully-made key, and will on his way home amuse himself by thinking out some of these interesting problems. Or the clergyman, when listening to the charming peals of the bells of his church, may recall the number of variations which could be made in the order of the Creative events.

It is probable that when Moses was on Sinai's top, God communicated to him these events, and I think with Hugh Miller, McCausland, and others, that He might have done so by a series of panoramic visions, for there is a vividness in the statements which would perhaps lead us to suppose that Moses saw what he has described. There is another confirmation of this view in the Patriarch's being told to construct the Tabernacle according to the pattern God had shown him while on the mount. Of this Tabernacle, then, he must have had a panoramic view, and indeed he could not otherwise have carried out the Divine directions, any more than a builder could erect a cathedral by receiving only verbal instructions from an architect. If, however, any other plan were adopted it would not at all affect my argument of the scientific accuracy of the order in which the events occurred.

Sincerely do I trust that before my readers have finished this book, they will be convinced that the statements of the Bible are indeed not "*myths*," but veritable revelations from our Creator and our God; that they are *truths* for our instruction and guidance, so that through life we may obey His will, and thereby insure for ourselves happiness and peace; that they are *truths* to teach us our high and noble origin, and thereby to incite in us holy desires and aspirations; that they are *truths* designed to console us in our trials whilst passing through this world, and to comfort and cheer us on the bed of death with the assurance of another life, happy, glorious, and eternal.

CHAPTER II.

"Let there be Light."

The Red Sea had been crossed, the Israelites had seen their enemies dead upon the shore, the cloudy pillar had removed from their rear to the van, and then this multitude of men, women, and children marched on—none of them knowing whither they would be led, or how they were to be provided with food and water in that great desert which was now before them. Soon, however, God manifested His special presence and superintending care by raining down for them bread from heaven, and by causing water to gush out of the "flinty rock." For several weeks did they journey on until they came to the wilderness of Sinai, and then were directed to halt.

Moses now received instructions to direct the people to sanctify themselves, and prepare for an event important and solemn which would take place on the mountain's top. For three days all was bustle in the camp; the people were washing their travel-stained clothes, and round the mount were erected barriers which none were to pass, on pain of death.

On the third day, when the people rose in the morning they saw a thick cloud on Sinai's summit; and when Moses had assembled them all together at the nether part of the mount, vivid flashes of lightning darted from the cloud accompanied with peal after peal of thunder. Smoke and fire ascended up to heaven, and the whole mount quaked and shook as though it would fall upon them all and crush them to atoms. Whilst they gazed with intense awe at this ter-

rific sight a trumpet was heard to sound; loud and long were its notes, and, as they waxed still louder and longer, Moses himself fell down and reverently besought the Divine Majesty to communicate to them His will. He ceased praying, and then God spoke to him with a voice audible to every Israelite, and called him up to the top of Sinai, where He renewed His directions that he should caution the people not to come near the mount. When Moses was descended, the lightnings and thunderings recommenced, and the trumpet blew a still longer and louder blast. At length all was still, and then the voice of God was heard proclaiming His laws, which afterwards He engraved on stone, and entrusted to Moses for the use of the whole world. But one feeling of reverence and intense fear filled every heart, and the people entreated Moses that they might receive God's further instructions through him alone. He cheered and comforted them by telling them that they need not fear, for God was only testing their obedience by giving them a glimpse of His glory and His power, and that if they sinned not by acts of disobedience all would be well. Then he withdrew within the thick cloud, and God communicated to him additional laws for the guidance of the people.

At the close of this second revelation, which was a commentary upon the decalogue, Moses was summoned to the top of the mount, and was hidden from the people for forty days. Seated on that holy place he had the high privilege of conversing with God "as a man converses with his friend," and, after receiving from Him still further laws in reference to the rituals to be observed by the Israelites in their future worship, the Past History of the World was communicated to him, and he probably was shown visions of six great Epochs of Creation.

Casting his eyes upwards, he saw the cloud which surrounded him moving, and soon a pitch-black sky was above

him; whilst wondering what this might mean, he heard the same voice of God saying—

"Let there be light,"

and immediately the whole of the expanse was filled with luminous Nebulæ of every variety of form. He gazes with admiration, and as he does so these Nebulæ condense, and suns and stars blaze forth throughout the whole canopy of Heaven.

How long this vision lasted we cannot tell, but this we know, that ages must have been compressed into seconds; for, though the Creator could doubtless have called everything as it now is into existence in a single moment of time, such a stupendous miracle would not have manifested His power so greatly as the ordaining of fixed laws which should bring about the present condition of the Universe.

The Rev. J. Gall has this excellent remark :—

"It is possible to conceive that a finite creature could make a flower, but it is impossible to conceive that he could ordain a law that would form a flower, because that would imply the possession of powers peculiar to God. The more wonderful the law, the more wonderful is God who made the law."

With regard to the order given in my first event of the creation of the Heavens before the Earth, I think I cannot do better than quote Dean Payne Smith's words in Bishop Ellicott's "Commentary for English Readers," which are :—

"As there never was a time when God did not exist, and as activity is an essential part of His Being (John iv. 17), so probably there was never a time when worlds did not exist, and in the process of calling them into existence when and how He willed, we may well believe that God acted in accordance with the working of some universal law of which He is Himself the author."

Now let us open the Book of Nature, and see what it teaches in reference to this first vision of Moses; and by reading there the processes that are now going on, we may be

able to learn what took place millions of years ago, when matter probably only existed in an exceedingly rare condition, the discovery of the continued existence of which occurred in this way:—A comet—first observed in 1786 by Méchain, and which revolves round the Sun in about $3\frac{1}{3}$ years—passed its perihelion on the 19th of December, 1838, as predicted by Encke, who had calculated its orbit in 1819 (when it was re-discovered by Pons), and who, by careful observations, detected that after each revolution it arrived at its perihelion $2\frac{1}{2}$ hours sooner; so that in 1789, when it had performed one revolution after its first discovery, the comet had been $1{,}212\frac{5}{10}$ days in going round its orbit; but on reaching its perihelion in 1838 it had been $1{,}211\frac{5}{10}$ days—a difference in 49 years of 41 hours.

This apparently simple scientific fact opened up a field of research and inquiry, which ended in the important conclusion that the whole of the space between the planets and the Sun, and between our Solar System and the Stars, was filled with matter in a very attenuated condition, but sufficiently dense to produce an effect on a body of such extreme tenuity as the comet in question.

An interesting investigation has been made by Lockyer and others, to ascertain whether all the chemical elements of Nature may not be one kind of matter under differently aggregated forms, and if so, this one element may be diffused throughout the Universe, and by Divine chemistry at different periods atom may coalesce with atom to produce the various elements which enter into the composition of Nebulæ, Suns, and Worlds.

Turning to a revised translation of the Pentateuch, written in 1789 by Isaac Delgado, a Hebrew scholar, I find that in speaking of Gen. i. 2, he says, "The Earth, the deep, and the waters mentioned in this verse, also signify the matter whence they were created."

Dean Colet also, in 1497, wrote several letters upon this subject, in one of which he says :—

"In the beginning the Earth was empty and void (*i.e.*, without solid, substantial being) and darkness covered the face of the deep (*i.e.*, the matter was in darkness, without life and being). The Spirit of God moved upon the face of the waters. See how beautifully he proceeds in order, showing at one view the creation and union of form with matter, using the word 'water' to express the unstable and fluid condition of matter."

Now Colet nearly 400 years ago, and Delgado 95 years ago, knew nothing of the scientific facts afterwards discovered by Encke and his successors, and yet the meaning they attach to the Hebrew words in this case are just such as we, with all our present knowledge, could desire.

I will repeat Moses' description, which has a depth of meaning perfectly sublime :—

"And the Earth was without form, and void; and darkness was upon the face of the deep. And the Spirit of God moved upon the face of the waters."

Now we will turn over another page in Nature's volume, and compare it with the second event mentioned by Moses.

Before the telescope revealed the hidden wonders of the skies, some of the early astronomers—amongst them Kepler and Tycho Brahé—entertained the belief that the Sun and stars were formed by the condensation of celestial vapours into spherical bodies. Kepler based his opinion on the phenomena of the sudden shining forth of new stars on the margin of the Milky Way. But it was when the telescope pierced the depths of celestial space, and brought to light the host of those marvellous objects called

NEBULÆ,

that the strongest evidence was afforded of the probable validity of these suppositions. Nasmyth and Carpenter, in

their admirable work on "The Moon," say:—"The mention of nebulous stars made by the earlier astronomers refers only to clusters of telescopic stars which the naked eye perceives as small patches of nebulous light; and it does not appear that even the nebula in Andromeda, although so plainly discernible as to be often now-a-days mistaken by the uninitiated for a comet, was known, until it was discovered by means of a telescope, in 1612, by Simon Marius, who described it as like a candle shining through semi-transparent horn, as in a lantern, and without any appearance of stars."

Forty years later Huygens discovered the nebula in the sword-handle of Orion, and in 1665 another was discovered by Hevelius. In 1667 Halley (afterwards Astronomer Royal) discovered a fourth; and so on gradually the numbers increased, until in 1783 Messier expanded the list of known nebulæ and clusters to 103, a catalogue of which appeared in the 'Connaissance des Temps' (the French "Nautical Almanac") for the year 1784.

This branch of celestial discovery, however, achieved its most brilliant results when the rare penetration, the indomitable perseverance, and the powerful telescopes of the elder Herschel were brought to bear upon it. In the year 1779 this great astronomer began to search after nebulæ with a powerful reflector of seven feet focal length and a diameter of 6¼ inches, which he afterwards superseded by the great telescope of forty feet focus and four feet aperture. In 1786 he published his first catalogue of 1,000 nebulæ; three years later he astonished the scientific world by a second catalogue containing 1,000 more; and in 1802 a third came forth comprising other 500, making 2,500 in all. This number has been so far increased by the labours of his son and other eminent astronomers, that the last complete catalogue of Sir John Herschel—published a few years ago—contains the places of more than 5,000 nebulæ and clusters.

At the earlier period of Sir William Herschel's observations, it is well known that that illustrious observer appears to have inclined to the belief that all nebulæ were but remote clusters of stars so distant, so faint, and so thickly agglomerated, as to affect the eye only by their combined luminosity; and at this period of the nebular history it was supposed that increased telescopic power would resolve these clusters into their component stars. Ultimately, however, he adopted the opinions held by previous philosophers, that they were composed of some vapoury or elementary matter, out of which, by the process of condensation, the heavenly bodies were formed; and this led him to attempt a classification of the known nebulæ into a cosmical arrangement, in which, regarding a chaotic mass of vapoury matter as the primordial state of existence, he arranged them into a series of progressive developments. His catalogue, which comprises upwards of thirty classes or stages of progression, is in the *Philosophical Transactions*, vol. ci., p. 271, *et seq.*

Laplace followed Herschel in these researches, and went considerably further; for he demonstrated how the known laws of gravitation could—and probably did—from such a partially condensed mass of matter, produce an entire Planetary System with all its subordinate satellites. This Nebular Hypothesis was put forth with much diffidence by Laplace; and yet it is generally thought that all the planetary phenomena give to those conjectures, to use his own modest language, "a probability strongly approaching certitude."

I think the most perfect and concise exposition of this wonderful hypothesis is given by Nasmyth, and therefore I will quote it *verbatim*:—

"Laplace conceived the Sun to be at one period the nucleus of a vast nebula, the attenuated surrounding matter of which extended beyond what is now the orbit of the remotest planet of the

system. He supposed that this mass of matter in process of condensation possessed a rotatory motion round its centre of gravity, and that the parts of it that were situated at the limits where centrifugal force exactly counterbalanced the attractive force of the nucleus, were abandoned by the contracting mass, and thus were formed successively a number of rings of matter concentric with and circulating around the central nucleus.

"As it would be improbable that all the conditions necessary to preserve the stability of such rings of matter in their annular form could in all cases exist, they would break up into masses which would be endued with a motion of rotation, and would in consequence assume a spheroidal form. These masses, which hence constituted the various planets, in their turn condensing, after the manner of the parent mass, and abandoning their outlying matter, would become surrounded by similarly concentric rings, which would break up and form satellites surrounding the various planetary masses; and, as a remarkable exception to the rule of the instability of the rings and their consequent breakage, Laplace cited the case of Saturn surrounded by his rings, as the only instance of unbroken rings that the whole system offers us, unless indeed we include the zodiacal light, that cone of hazy luminosity which is frequently seen streaming from our luminary shortly before and after sunset, which Laplace supposed to be formed of molecules of matter too volatile to unite either with themselves or with the planets, and hence must circulate about the Sun in the form of a nebulous ring, and with such an appearance as the zodiacal actually presents."

Nasmyth says, "This hypothesis, in spite of its disbelievers, has never been overthrown, but remains the only probable, and, with our present knowledge, the only possible explanation of the cosmical origin of the planets of our system."

The spiral form of some of the Nebulæ seems to confirm this theory very much, for it would be impossible to conceive of such a form existing *without internal motion*. Fig. 5, from Dunkin's edition of "Lardner's Handbook of Astronomy," is a good illustration of such a nebula.

At one time it seemed that the whole theory would fall to the ground; for when Lord Rosse's giant reflector was turned upon these Nebulæ he was able to resolve into stars many that had been hitherto supposed irresolvable, and therefore at first thought that he should be able to show that they were masses of stars at enormous distances. However, within the last few years a new science has arisen which furnishes us with fresh powers of penetration into the vast and secret laboratories of the Universe; for by means of Spectrum Analysis, Dr. Huggins

Fig. 5.—Spiral Nebula.

and other eminent physicists have been able to prove beyond all question that many of the Nebulæ are large masses of incandescent gas, and that therefore Kepler and the early astronomers were right in their suppositions.

Doubtless some of my readers will ask how a gaseous substance can remain incandescent for centuries, and apparently of nearly the same form, it may be, for ages, without any central source of heat. To this we must reply that at present we cannot tell, and that it is one of the undiscovered secrets of Nature. It is extremely probable that we shall some day find a solution in one of the many forms of electrical action.

One of the most beautiful Nebulæ, which has had nearly the same form for at least the past century, is that called the "Dumb-Bell" (Fig. 6). Herschel gave it this name, because it appeared of such form in his telescope. Our illustration, also from Dunkin, shows its appearance in Lord Rosse's telescope of 3 feet aperture and 27 feet focal length. Sir John

Fig. 6.—The Dumb-Bell Nebula.

failed to resolve it, and Dr. Huggins has since shown that its light gives a spectrum of one bright line, thus placing it in the class of gaseous nebulæ; consequently it is irresolvable.

Here, then, you see how correctly the first step in creation was described by Moses, and that this remarkable accuracy has been confirmed by the very latest scientific discoveries.

Could anything be more interesting than the discovery, through the observed resistance to Encke's comet, of matter in a highly-attenuated condition, agreeing with the transla-

tion of Isaac Delgado, who wrote half a century before him, both showing that in that remote "Beginning" the materials for the composition of worlds probably existed without any form, and also without light; next, that Laplace should propound a theory which, with some modifications, the investigations of Huggins and other eminent astronomers have in so remarkable a manner confirmed? And do not these facts tend to prove that other worlds were formed from Nebulæ before the creation of our Solar system?

Though we cannot at present tell by what laws Nebulæ are formed and endowed with luminous properties, yet here is the remarkable fact of light existing without any known central source of radiance. Therefore Moses was quite right in mentioning *light* before the Sun; for, though he might have seen in this first vision the further condensation of Nebulæ into Suns and Worlds, yet a confusion of the order might have occurred had he related to us that he had done so.

There are some lines of Milton upon this subject which are very remarkable, and the more so as his science is often greatly at fault, writing as he did before even the laws of gravitation were known; the passage is as follows:—

> "'Let there be light!' said God; and forthwith light
> Ethereal, first of things, quintessence pure,
> Sprung from the deep, and from her native East
> To journey through the aëry gloom began,
> Sphered in a radiant cloud, for yet the Sun
> Was not."
>
> (*Par. Lost*, bk. vii., 243.)

Though there are a few phrases in these lines not quite correct, yet it will be seen that, unknowingly, Milton actually enunciated the nebular hypothesis.

Taking a step further in the creative processes, Schellen and other philosophers seem to think that

COMETS

may be Nebulæ somewhat more condensed, and brought within

the influence of the Sun's attraction. If this be so, a very interesting field of research is opened in their careful study. There is, however, one objection to this, which is that the spectrum of a comet differs greatly from that of a nebula. Still it may be that some changes in the condition of nebulous matter, on thus being brought within the solar influence, will account for the difference.

At the meeting of the British Association in 1881, Dr. Huggins read a very interesting paper on the Photographic Spectrum of Tebbutt's Comet (*b*, 1881), then shining so brilliantly in our sky; and he stated that the photographs which he succeeded in obtaining confirmed his earlier observations on comets, that part of their light is reflected sun-light, and part is original light, and, further, that carbon is present in the cometary matter. He added that there is strong evidence of nitrogen and hydrogen entering into their composition.*

Seeing how terrific comets appear to those who are ignorant of their nature, it is not to be wondered at that the ancients looked upon them with dread, considering them as messengers of wrath laden with the destinies of monarchs and nations. Tacitus has commemorated in two passages the universal belief respecting them; in one he says:—

"Whilst these things were occurring a star comet shined forth, of which comet it is the common notion that it portends a change in the monarchy."—*Annals*, lib. xiv., c. 22.

Again, in *Annals*, lib. xv., c. 47, we find these words:—

"Towards the close of this year there were prodigies, the fore-

* Whilst I was revising the seventh edition, a comet discovered more than seventy years ago was leaving us, after having been visible for some months, and furnishing another opportunity of ascertaining more of the constitution of these wondrous bodies; it was nearest the Sun on the 25th January, 1884. This comet at its previous return was in that position on the very day that the fire broke out which compelled Napoleon to retreat from Moscow in 1812.

runners of impending misfortunes. Never were there before seen such incessant flashings of lightning, and, with a comet star, certain to be expiated by the imperial blood of Nero."

Suetonius seems to consider comets as omens of good, for he says, at the conclusion of his biography of Julius Cæsar :—

"He perished in the 56th year of his age, and was enrolled amongst the gods; not merely in the opinion of those who made such a decree, but in accordance with the universal opinion respecting him; for in the public games, which his heir Augustus had consecrated to his honour, there appeared a comet (*stella crinita*) which, arising at the eleventh hour, shone forth for seven days continually. It was hence believed that the soul of Cæsar was received into heaven, and, on account of the comet, a star was affixed to the head of his images."

The superstitious notion that comets were celestial indications of great social and political changes in the condition of mankind was not confined to the ancients; this strange idea did not disappear from the imagination of mortals even with a knowledge of Christianity. Our English bard Shakespeare appears to acquiesce in the old notions respecting them, as well as in the general belief in astrology, and the universal conviction that the stars influenced the lives and fortunes of mortals. In the following lines he describes the Duke of Bedford as pouring forth an angry lamentation for the untimely death of the hero of Agincourt :—

> "Hung be the heavens with black, yield day to night!
> Comets importing change of time and state,
> Brandish your crystal tresses in the sky;
> And with them scourge the bad revolting stars,
> That have consented unto Henry's death."

And again in his "Julius Cæsar" (act ii., sc. 2) :—

> "O Cæsar! these things are beyond all use,
> And I do fear them.
> When beggars die there are no comets seen;
> The heavens themselves blaze forth the death of princes."

Even when astrology was no longer considered a science,

comets were still looked upon with dread lest they should set the world on fire. In 1832 there was a report that Biela's comet would cross the orbit of the Earth in the month of October; this rumour created alarm throughout Europe, as the people feared that the comet would come into collision with the Earth and burn it up. So great, indeed, was the excitement, that some are said to have died from fright at the mere anticipation of such a catastrophe.

The Institute of France commissioned M. Arago to calculate the place of the Earth when this comet should cross its orbit. He did so, and found that by the time the Earth reached the dreaded spot the comet would be fifty millions of miles away. That somewhat allayed the consternation, but not wholly so; although we probably should scarcely have known it if the Earth had run right into the comet.

Mr. Woolhouse calculated the ephemeris of Biela's comet for the "Nautical Almanac," and constructed a model of its orbit, which he presented to Sir John Herschel, who was not a little pleased with it.

Sir John Herschel, whilst observing this very comet in England in the same year, saw it pass before a group of stars of the sixteenth magnitude without concealing them, although the nucleus with the coma was more than forty thousand miles in thickness. This proves how extremely attenuated must have been the matter composing the comet, for a very thin stratum of cloud will often obscure even the brightest stars.

A very interesting illustration of the extreme tenuity of comets occurred in 1858, when Donati's passed in front of the star Arcturus, which was seen to shine with undiminished brightness through a part of the tail, not far from the head, where it was some 54,000 miles in thickness. Fig. 7 shows that comet as it was just approaching the star. I watched them both from day to day with intense interest.

In the year 1861 it is pretty certain that our Earth plunged through the tail of a comet without suffering any harm, and without any one noticing a difference in the condition of the atmosphere, excepting astronomers, who were watching it carefully, and they spoke of the effect as simply a slight yellowness in the sky. Mr. Hind of London, and Mr. Lowe of Highfield

Fig. 7.—Donati's Comet about to pass in front of Arcturus.

House, both noticed the auroral glare-like appearance which seemed to subdue the light of the Sun.

Some comets appear to have several tails; that of 8th March, 1744, is said to have had six, each 4° in breadth (Fig. 8).

The rarity of the material of comets is shown by the fact that, although obedient to the laws of gravitation, they produce no appreciable effect upon the motions of the planets or their satellites, even when passing very near them.

In 1770 Lexell's comet came so near to us, that if it had been of the same density as the Earth it would have retarded

Fig. 8.—The Comet of 1744.

the latter, and lengthened the year three hours, and it would also have raised the tides mountains high. But the year was not increased by the fraction of a second, nor were the tides perceptibly raised in the slightest degree. As,

however, this is a small comet, we could not be certain of the effect of the nucleus of a large one.

Though comets may be reckoned amongst the lightest bodies in Nature, they are undoubtedly the largest; the nuclei and comæ of some of them when in certain positions in their orbits are larger than the Sun, and their tails even hundreds of millions of miles in length. The nucleus and surrounding coma of the comet of 1811 was estimated at over a million of miles in diameter, and its tail was a hundred and thirty millions of miles in length. This was one of the most beautiful comets ever seen, of which Fig. 9 is but a faint representation. The tail of the comet of 1843 was two hundred millions of miles in length; a size which, perhaps, may to some extent be appreciated by reflecting that an express train at the rate of fifty miles an hour travelling day and night would take 450 years to pass from the nucleus to its extremity. Some of their orbits are very large: that of the comet of 1811 extends for a distance fourteen times farther off the Sun than Neptune—that is, about 40,000,000,000 miles. This comet has been calculated to take 3,065 years to go round its orbit.

The aphelion distance from the Sun of the comet of 1843 was reckoned at the enormous distance of 406,130,000,000 miles; and though these aphelion distances are so great that the temperature of those far-off regions through which the comets pass must be at least 250° below freezing, yet many of them approach so near to the Sun, that at their perihelion the heat would be forty thousand times greater than that of our equatorial regions, sufficient to disperse metals into vapour, and twenty-four times greater than what would melt rock crystal. The capability of undergoing such enormous differences of temperature without being destroyed, renders these bodies a still greater puzzle to philosophers.

When passing round its perihelion, the tail of the comet

is always turned away from the Sun, as shown in Fig. 10. At what an enormous rate, therefore, must the end of the tail

Fig. 9.—The Comet of 1811.

move which is two hundred millions of miles long! No figures can help the mind to grasp the velocity.

And now I have a very interesting story to tell in reference to the calculation of the orbit of Halley's comet, one of the largest and most beautiful, which returns about every 76

years, and has been traced back in history by Hind to 12 B.C., the year of the death of Agrippa, to whom the Roman Emperor, Augustus, owed the victory of Actium. At its appearance in 1682, Halley, the second Astronomer Royal, pointed out that it was probably identical with comets seen in 1456, 1531, and 1607; he calculated that it would return again in 1758 or 1759, and called upon posterity to remember that an Englishman had predicted the event.

As 1758 approached there was much curiosity and interest

Fig. 10.—A Comet passing round its Perihelion.

excited as to whether the prediction would be verified; and Lalande in 1757, remarking, "We cannot doubt it will return," set to work with Clairaut and Madame Lepaute to calculate the attractive influence of Jupiter and Saturn upon the comet, which might change to some extent the time of its arrival at perihelion. "During six months," he remarks, "we calculated from morning till night, sometimes even at meals; the consequence of which was that I contracted an illness which affected my constitution for the remainder of my life. The assistance rendered by Madame Lepaute was such that without it we never could have dared to undertake

this enormous labour, it being necessary to calculate for every degree of longitude for 150 years the distance and force of each of the two planets with respect to the comet."

In November, 1758, they announced to the Academy of Sciences at Paris that they had discovered that the comet would be retarded 100 days by Saturn and 518 days by Jupiter, and that therefore it would return to its perihelion within thirty days of the 11th of April, 1759—giving themselves this margin on account, they said, of the possible attraction of an undiscovered planet of our system revolving beyond the orbit of Saturn.

And, marvel of marvels! they were right, and within their own margin, for the comet passed its perihelion on the 13th of March, 1759. Halley's prediction was also verified, for John George Palizsch, a Saxon farmer and amateur astronomer, saw the comet first on Christmas Day, 1758. Well does Halley therefore deserve that it should be named after him to recall to our minds his wonderful prescience. The hypothetical anticipation by Lalande of the discovery of Uranus—which took place twenty-two years afterwards —was also very remarkable.

Before the next seventy-six years had passed away astronomers were again calculating the comet's return, and several eminent foreigners were very successful in fixing the date. I must, however, tell the story of the brilliant achievement of an Englishman.

Mr. Wesley S. B. Woolhouse, who, though only twenty-three years of age, had attained to a very high amount of mathematical knowledge, and was then engaged by Government in the "Nautical Almanac" office, undertook the calculation of the elements of the comet's ephemeris—that is, the position it would occupy in the heavens each day whilst visible, and also its distance from the Earth. Alone in his study, and after only three weeks' labour, he found himself completing

the work. Stimulated by his success he persevered, and for the last three days and nights he sat hour after hour, taking no rest and no sleep. At last, on a Saturday evening, he finished the calculation, and drawing up an article for publication, took it himself to the *Times* Office in Printing House Square and dropped it into the Editor's Box. After retiring to his much-needed rest he fell into so sound a slumber that he got up, as he supposed, the next morning thoroughly refreshed. Sitting down to breakfast, he was surprised to see the *Times* lying on his table, for he thought it was Sunday morning; but there it was, forsooth, and his own article in unmistakable type. He therefore had slept from Saturday night till Monday morning; and well was it for him that his mind and body had thus been refreshed, or he might, like Lalande, have suffered for the feat all his life.

The comet arrived at its perihelion on the 16th of November, 1835, as predicted by Mr. Woolhouse, and all the positions for the respective dates, as given by him, in the ephemeris were perfectly correct.

I have the more pleasure in relating this anecdote of Mr. Woolhouse, since I have enjoyed his friendship for over twenty years; and though he was a young bachelor when he achieved this wonderful calculation, I have since had the pleasure of educating three of his sons.

Some ten years ago his native town, North Shields, paid him a high tribute of its esteem, and at the banquet given in his honour, he was spoken of with pride. Dr. Dodd, when proposing Mr. Woolhouse's health, said, he

> "——— was gentle, and the elements
> So mixed in him, that Nature might stand up
> And say to all the world—'This is a man.'"

As a further mark of esteem, his likeness, painted by Shotton, and paid for by his own townsmen, was hung up in the Mechanics' Institute.

I mentioned that he was engaged in the "Nautical Almanac" office when he accomplished the above masterly calculation; while there he also constructed formulæ whereby the tables were calculated with greater accuracy and speed: of this a Northern writer says—

"Little do our Shields captains think, when reckoning their latitude and longitude on the vast surface of the apparently boundless ocean, perhaps, that the method by which they accomplish it originated in the brain, and was written by the hand, of the great mathematician, their townsman."

For years Mr. Woolhouse wrote important astronomical articles as appendices to the "Nautical Almanac," and he continues to edit the almanacs published by the Stationers' Company, besides being the consulting actuary for a number of insurance companies. There is every prospect also of his continuing these important works for years to come, for though time has whitened his hair, it has left him still vigorous in body and bright in intellect.

We will now advance another step in the condition of matter. A most remarkable phenomenon was noticed in 1845, when Biela's comet was seen divided into two parts, each being a separate comet, but both pursuing their course in the same orbit. When observed on the 26th of November, it appeared as a faint nebulous spot not perfectly round, and with an increased density towards the middle.* On the 19th of December it was rather more elongated; and ten days later it had divided into two separate cloudy masses, each furnished with a nucleus and tail, and for three months one followed the other at an apparent distance of one-tenth, and subsequently one-fifth of the Moon's diameter. Then they both passed from sight; but in 1852 the pair made their appearance again, having travelled together in one common orbit round the Sun for more than six years and a half; but the

* A late eminent American astronomer, Professor Hubbard, has shown that the separation probably took place in 1844.

distance between the two had much increased, and now had reached 1,404,000 miles.

When they should have returned, however, in 1859, astronomers looked for them in vain; again in 1866, notwithstanding the most diligent search, they were not to be found; and therefore, probably, as subsequent circumstances have shown, they had ceased to be comets by passing into some other form of existence.

This form is thought to be that of

METEORITES.

It is quite evident that there is an affinity between comets and meteors, and that their orbits are coincident with one another. Among the eminent astronomers who have made the most careful calculations and observations upon the connection between these mysterious heavenly bodies, are Adams, Le Verrier, Schiaparelli, Chladni, Peters, Oppolzer, Heis, and Bruhns. Of these, perhaps, Schiaparelli of Milan stands first in his successful observations and ingenious theories, of which Schellen gives the following account:—

"As a comet is not a solid mass, but consists of particles each possessing an independent motion, the head or nucleus nearer the Sun must necessarily complete its orbit in less time than the more distant portions of the tail. The tail will therefore lag behind the nucleus in the course of the comet's revolution, and the comet, becoming more and more elongated, will at last be either partially or entirely resolved into a ring of meteors. In this way the whole path of the comet becomes strewn with portions of its mass, with those dark meteoric bodies which, when penetrating the Earth's atmosphere, become luminous and appear as falling stars. Instead of a comet there now revolves round the Sun a broad ring of meteoric stones, which occasion the phenomena we every year observe as the August meteors. Whether this ring be continuous, and the meteoric masses strewn along the whole course of the path of the original comet, or whether the individual meteors—as in the November shower—have not filled up entirely

the whole orbit, but are still partially in the form of a comet, is in the transformation of a cosmical cloud through the influence of the Sun only a question of time; in course of years the matter composing a comet which describes an orbit round the Sun must be dispersed over its whole path. *If the original orbit be elliptical, an elliptic ring of meteors will gradually be formed from the substance of the comet, of the same size and form as the original orbit.*"

Schellen goes on to say that—

"Schiaparelli has, in fact, discovered so close a resemblance between the path of the August meteors and that of the comet of 1862, No. III., that there cannot be the least doubt of their complete identity. The meteors to which we owe the annual display of falling stars on the 10th of August are not distributed equally along the whole course of their orbit; it is still possible to distinguish the agglomeration of meteoric particles which originally formed the cometary nucleus from the other less dense parts of the comet: thus in the year 1862 the denser portion of this ring of meteors through which the Earth passes annually on the 10th of August, and which causes the display of falling stars, was seen in the form of a comet with head and tail, as the densest parts approached the Sun and Earth, in the course of that month.

"Oppolzer, of Vienna, calculated with great accuracy the orbit of this comet, which was visible to the naked eye. Schiaparelli had previously calculated the orbit of the meteoric ring to which the shooting stars of the 10th of August belong before they are drawn into the Earth's atmosphere.

"The almost perfect identity of the two orbits justifies Schiaparelli in the bold assertion that the comet of 1862, No. III., is no other than the remains of the comet out of which the meteoric ring of the 10th of August has been formed in the course of time.

"The difference between the comet's nucleus and its tail that has now been formed into a ring, consists in that while the denser meteoric mass forming the head approaches so near the Earth once in every hundred and twenty years as to be visible in the reflected light of the Sun, the more widely scattered portions of the tail composing the ring remain invisible, even though the Earth

passes through it annually on the 10th of August. Only fragments of this ring, composed of dark meteoric particles, become visible as shooting stars when they penetrate our atmosphere by the attraction of the Earth, and ignite by the compression of the air."

I have purposely given at length this quotation from Schellen's Spectrum Analysis, which was translated by the daughters of the late eminent astronomer Mr. Lassell, F.R.S., then President of the Royal Astronomical Society, and edited by Dr. Huggins, F.R.S., one of our most eminent spectroscopists. A better book I do not think exists upon the subject.*

Who is there that has not on a starlight night been suddenly attracted by seeing a bright light resembling a star darting across the sky, but generally more brilliant than any of the heavenly bodies? And whilst gazing in admiration, in a moment it has entirely vanished. Every one now knows, as I have already explained, that it is no star at all, but simply a mass of matter attracted from its orbit by the Earth, and its rapid passage through the air has rendered it so hot that it generally becomes dissipated into a luminous gas; at other times such a body is large enough to remain solid until it reaches the Earth, and then it has been improperly called a thunderbolt—probably because its fall is sometimes accompanied by a noise resembling thunder.

As far back as records go, we meet with allusions to luminous meteors; but the ancients looked upon them as supernatural appearances, or as the gifts of the gods descending from the skies. Such, perhaps, was the Palladium of Troy, the sacred shield of Numa, the Caaba at Mecca, and many other similar prodigies. The hasty flight of Minerva from the peaks of Olympus to break the truce between

* Longmans and Co.

the Greeks and the Trojans, is compared by Homer to the emission of a brilliant star, an idea probably suggested by the fall of an aërolite.

Virgil, in the first book of his "Georgics," mentions shooting stars as prognosticating weather changes:—

> "And oft, before tempestuous winds arise,
> The teeming stars fall headlong from the skies,
> And, shooting through the darkness, gild the night
> With sweeping glories and long trains of light."

Livy relates that a shower of stones fell at Rome in the reign of Tullus Hostilius, 654 B.C.; Pliny, that a shower of stones and a shower of iron fell a year before the defeat of Crassus, 53 B.C.

Coming down to the Middle Ages, there is an interesting account of the fall of a meteoric stone, which was written at the time by the order of the Emperor Maximilian, and deposited with the stone in the neighbouring church. It states that it fell at Ensisheim in Alsace, A.D. 1492, on the 7th of November, accompanied by a loud clap of thunder, and a prolonged confused noise; that it fell in a field in the district of Giscano, and weighed 260 pounds. It was placed in the church, for all the people looked upon it as a miracle, where, after remaining undisturbed for three centuries suspended in the choir, it was carried off to Colmar during the French Revolution. Several pieces were broken from it, of which one is in the Museum of the Jardin des Plantes at Paris, and another in the British Museum. This aërolite is precisely identical in its chemical composition with other meteoric stones.

A curious extract, translated from the Emperor Tchangire's memoirs of his own reign, is given in a paper communicated to the Royal Society, which speaks of the fall of a metallic mass in India. The prince relates that in the year 1620 (of our era) a violent explosion was heard at a village in the

Punjaub, and at the same time a luminous body fell through the air to the earth. It was afterwards sent to court, where the emperor had it weighed in his presence, and ordered it to be forged into a sabre, a knife, and a dagger. On attempting to carry out this order, the workmen reported that the mineral was not malleable, but shivered under the hammer; and it required to be mixed with one-third part of common iron, when the mass was found to make excellent blades. The royal historian adds, that "on the occasion of the iron lightning being manufactured," a poet presented him with a distich, which might be thus translated:—

"During thy reign, O mighty Prince, the Earth has attained to order and regularity; and raw iron falling from lightning was by thy world-subduing authority converted into a dagger, a knife, and two sabres."

The accompanying sketch (Fig. 11), from Flammarion's "Atmosphere," will enable my readers to form an idea of the shape of some of these aërolites; it represents one which fell at Caille, in the department of the Maritime Alps, some years ago, which the people carefully placed in the porch of their church, where it remained for some time, and was used as a seat. It has since been removed to the Museum of the Jardin des Plantes, and weighs 12¼ cwt. One can imagine what mischief such a large block would do if it came thundering and crashing down upon one of our houses or public buildings.

The cause of the fall of these bodies was at one time a great mystery, and philosophers could not agree as to their origin. Laplace, Poisson, and others supposed they came from the Moon, not knowing that all its volcanoes had been silent ages before. Baccaia and Vassali thought that electricity would solve the problem; whilst others even supposed at the masses had been thrown out of our own volcanoes h such force as to revolve round the Earth for some days

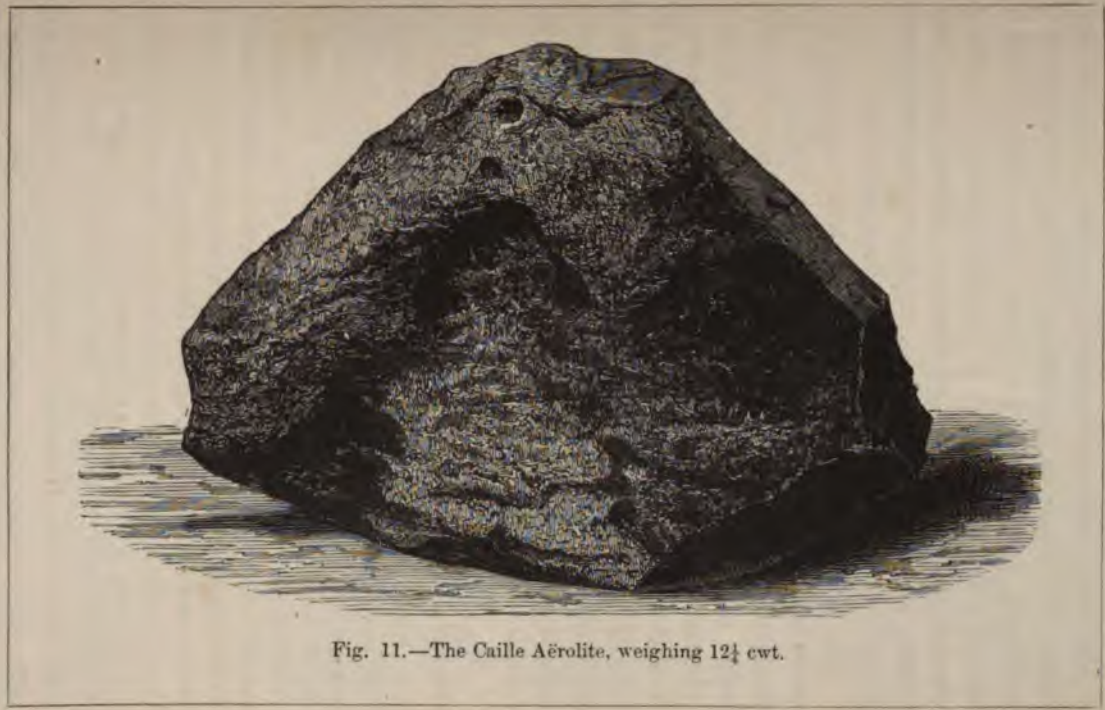


Fig. 11.—The Caille Aërolite, weighing 12¼ cwt.

as satellites, and that finally they were drawn to the surface in the form of fireballs, meteors, or bolides.

All these theories are entirely exploded; for it is now known that enormous aggregations of these meteoric masses are passing round the Sun in more or less elliptical orbits, some of which cut the orbit of our planet, and at the points where they do so numbers of them are attracted from their courses, and fall upon the globe, varying in size from atoms of dust to large stones sometimes weighing many tons.

Sir Humphry Davy, in a paper which contains his researches on flame, came very near to the truth; in it he strongly expresses an opinion that the meteorites are solid bodies moving in space, and that the heat produced by the compression of the air from the velocity of their motion must be sufficient to ignite their mass, so that they are fused on entering the atmosphere. He calculated that the heat they extricated from the atmosphere exceeded 30,000° of Fahrenheit—a heat more intense than that of the fiercest artificial furnace that ever glowed.

Dr. Phipson, in his excellent little work on Meteors and Aërolites, says that—

"Knowing the velocity of a body in the air, the researches of Professors William Thomson and J. P. Joule enable us to obtain some idea of the heat produced by friction of a bolide against the air, in its rapid passage through our atmosphere. The temperature ultimately acquired by the moving body is the equivalent of the force with which the particles of air come into contact with it. This temperature is 1° Centigrade for a velocity of 145 feet per second, and goes on increasing with the square of the velocity; so that the ultimate temperature acquired by a body moving through the air with a velocity of thirty-nine miles per second will be about 2,000,000° Centigrade" (that is, 3,600,000° Fahr.).

This exceeds Sir Humphry's calculation a hundredfold, and will quite account for meteors generally being dispersed into luminous gas before reaching the Earth.

In the months of August and November more of these meteors are seen glancing across the sky than during other months; and about every thirty-three years, in the month of November, the display is of the grandest description.

The Moravian missionaries in Greenland related that on the 13th of November, 1799, the hemisphere presented a most magnificent and astonishing spectacle; fiery particles as thick as hail crowded the sky, as though some magazine of combustion in celestial space were discharging its contents towards the Earth. Humboldt, travelling in South America at the time, thus speaks of it:—

"Towards the morning we witnessed a most extraordinary scene of shooting meteors. Thousands of bodies and falling stars succeeded each other during four hours. Their direction was very regular from north to south. From the beginning of the phenomenon there was not a space in the firmament equal in extent to three diameters of the Moon which was not filled every instant with falling stars. All the meteors left luminous traces or phosphorescent bands behind them, some of which lasted for seven or eight seconds."

By far the most splendid display on record, surpassing in grandeur the most imposing artificial fireworks, was on the 13th of November, 1833. An incessant play of dazzlingly brilliant luminosities was kept up in the heavens for several hours. Some of them were of considerable magnitude and peculiar form. One, of large size, remained for some time stationary in the zenith over the Falls of Niagara, emitting streams of light. The wild dash of the waters, as contrasted with the fiery uproar above them, formed a scene of unequalled sublimity. In many districts the people were terror-struck, and even the more enlightened were filled with awe. A planter of South Carolina thus describes the effect of the scene upon the ignorant negroes:—

"I was suddenly awakened by the most distressing cries that ever fell on my ears. Shrieks of horror and cries for mercy, I

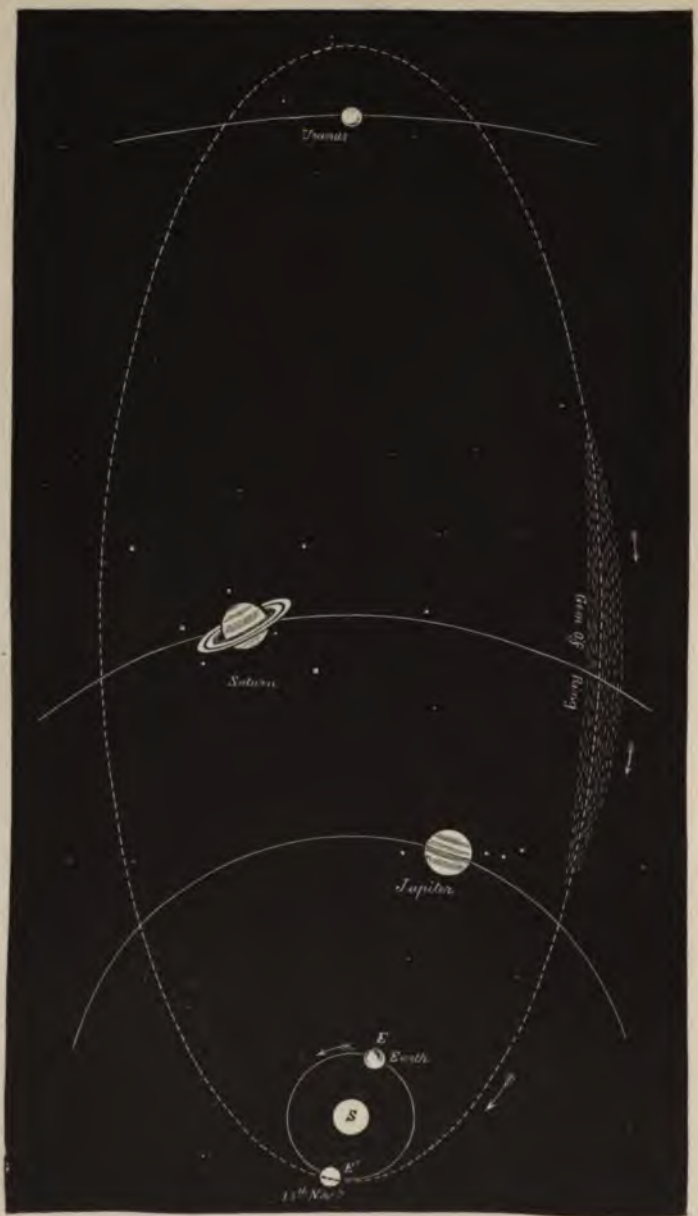
could hear from most of the negroes of the three plantations, amounting in all to about six or eight hundred. While earnestly listening for the cause, I heard a faint voice near the door calling my name. I arose, and, taking my sword, stood at the door. At this moment I still heard the same voice beseeching me to rise, and saying, 'O my God, the world is on fire!' I then opened the door, and it is difficult to say which excited me most—the awfulness of the scene, or the distressed cries of the negroes. Upwards of a hundred lay prostrate on the ground—some speechless, and some with the bitterest cries, but with their hands raised, imploring God to save the world and them. The scene was truly awful; for never did rain fall much thicker than the meteors fell towards the earth on this night—east, west, north and south, it was the same."

Long before the thirty-three years after this exciting scene had expired, astronomers were predicting the display that would take place on the 13th of November, 1866; and anxiously was the event looked forward to, with sincere desire that the weather might be favourable. And in no way were people disappointed: tens of thousands sat up that night to witness the celestial fireworks, and amongst them our gracious Queen.* Every mind was filled with admiration, almost amounting to awe, when looking at the glorious display; and for some weeks after, the event was the talk of the world, and the theme of the newspapers. Astronomers also received a fresh impulse to the more careful study of these interesting phenomena.

Well do I remember attending the first meeting of the Royal Astronomical Society a few evenings after the occurrence, when Professor Adams, the contemporary discoverer with M. Le Verrier of the planet Neptune, read a paper which intensely interested me. He described, in his lucid and forcible style, the orbit in which these innumerable meteors travelled round the Sun, not massed together in

* His late Royal Highness the Duke of Albany told me that the Queen had all the children called up to see this remarkable sight.

[redacted]



I.—Orbit of November Meteors, &c.

one place, but spread all along the orbit and passing round the Sun—something like the band of leather employed to move different parts of machinery, only the meteoric band or ring is much thicker in some places than in others. Further study has confirmed all that the Professor stated on that occasion, and much more is now known.

My diagram (Plate I.) * will give you some idea of this November meteor-ring; its perihelion is about ninety millions of miles from the Sun, and its aphelion is beyond the orbit of Uranus. The longer diameter of the orbit is 1,885,000,000, and the circumference about 4,400,000,000 miles. You will see that it cuts the Earth's orbit in one place, E', which happens about the 13th of November; and every year on that date a different portion of the ring is passed through, and a considerable number of meteors are encountered, which is proof positive that meteoric masses, aggregated more or less thickly, occupy the whole circumference of the orbit.

But as it has been found that once in thirty-three years the number of falling meteors immensely increases, and the brilliant display lasts for hours, it is certain that a part of the ring is richer than others, and this part is poetically called the gem of the ring, which I have shown approaching the Earth on the right-hand side.

Let us endeavour to form some idea of the vastness of the mass of meteors in this part of its orbit. Supposing the display to last six hours—that is, from its commencement in India to its finish in England—then the Earth moving in its orbit at the rate of 68,000 miles an hour would plunge through 408,000 miles of these meteors; but, as the Earth and the meteors are moving in opposite directions, this number of miles would be probably doubled, and the Earth turning on

* It must be understood that the figures of the Sun and Planets are not drawn according to their proportionate sizes in the opposite diagram, for if they were the planets would be almost invisible.

its axis at the rate of about 1,000 miles an hour being also taken into consideration, would give a further increase.

Then we must remember that this is only a calculation for six hours, and this dense part of the ring is nearly three years passing its perihelion where the meteor stream moves at its greatest velocity; and therefore the length of the rich part of the ring cannot be much less than a thousand millions of miles, and the depth has been estimated at a million miles!

To grasp the idea of the number of meteors in this group is almost beyond us, as they must amount to many millions of millions. And these compose only a small portion of one ring out of myriads of such orbits; for astronomers have recognised one hundred meteoric orbits such as I have just described, and by an excellent piece of reasoning Proctor shows that there may be even millions of them.

Professor H. A. Newton, an eminent American astronomer, has calculated, from perfectly reliable data, that on an average in the course of a single day 7,500,000 meteors, large enough to be visible to the naked eye, and about 400,000,000 such as could be seen with a telescope of moderate power, are ignited in the Earth's atmosphere, and that the meteoric dust (magnified in Fig. 12) falls to the surface. Now if we consider those visible to the naked eye as only weighing a grain each, and those only visible through a telescope a fiftieth of a grain, we shall have fifteen millions of grains as the Earth's daily increase of weight, or a little less than a ton. Then in the course of three years (even on the very low value here assigned to a meteor's weight) the Earth's weight must increase by a thousand tons, and in 3,000 years by a million tons. Great as this amount of meteoric matter may seem to be, if spread over the whole globe it would not exceed half an inch in depth; and, therefore, at the same rate, it would take 72,000 years for such matter to be deposited one foot in depth.

Though I have mentioned so small a weight as a grain, it must not be forgotten that single meteors have fallen weighing several tons. The one in the British Museum, which fell near Melbourne in Australia, weighs over three tons, and Proctor mentions one weighing fifteen tons.

Now it is also certain that if so many meteors fall to the Earth, a number vastly greater must fall into the Sun; for all the myriads of meteoric orbits intersect one another at every

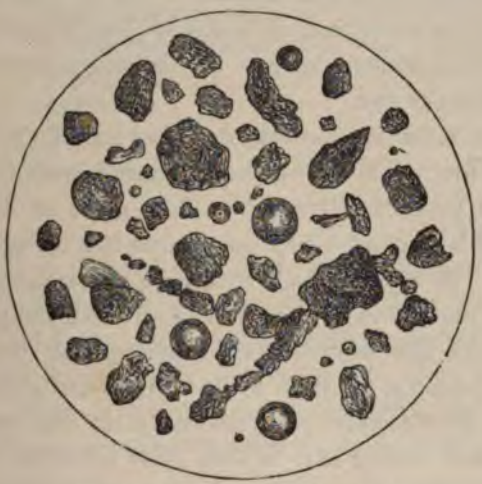


Fig. 12.—Meteoric Dust Magnified.

possible angle when at their perihelion, and as some of the masses have a forward and others a retrograde motion, they must come into continual collision; the consequence of which is that both bodies come to a sudden stop, an enormous amount of heat and light is thereby generated, and they fall at once into the solar orb, furnishing it with a fresh supply of light and heat.

Here, then, we see that these meteors help to serve as *fuel* to this great furnace. I say "help," because there can be no doubt that much of the solar heat is generated by contrac-

tion. Helmholz calculated that the shrinking of the Sun's diameter by $\frac{1}{10000}$th part of its present length would generate an amount of heat competent to cover the solar emission for 2,000 years. This seems too great an estimate; but there can be no doubt that the two things combined produce these mighty results of heat and light. The fact will be better understood when I say that from every square yard of the Sun's surface there flashes into space an amount of heat equal to that of a blast-furnace consuming a ton of coals every ten minutes, which would be equal to 300,000,000,000,000,000,000 (three hundred trillions) of tons for the whole surface of the Sun for only one day.

But it must not be supposed that anything like this amount of fuel would be required, or even a small fraction of it; for, as we have before shown how great an amount of heat would be engendered by the passage of a meteor through the air, so we could also show that an enormous additional amount of heat would be the result of a sudden stoppage in its passage, since this motion would be immediately transformed into its equivalent of heat, which can be easily calculated. Therefore, these meteors being drawn by the Sun from great distances, and falling into it with great velocities, the heat generated would be so excessive that I could scarcely describe it to you in figures; perhaps Sir William Thomson's illustration will help you to understand it. He says that if the planet Jupiter were to fall into the Sun it would evolve by the shock as much heat as the Sun would give out in 32,240 years.

It is evident, therefore, that meteoric masses have had much to do with the building up of suns and worlds, and it is not a little interesting to find that such masses when analysed are found to be composed of the same elements as our Earth, our Sun, and the far-distant Stars. The following is the analysis of a meteor that fell near Tulbach, Cape of Good Hope:—

Metallic Iron	2·50
Nickel	1·30
Sulphur	3·38
Silica	30·80
Protoxide of Iron	29·94
Magnesia	22·20
Lime	1·70
Alumina	2·05
Oxide of Chromium	0·76
Potassa and Soda	1·23
Oxide of Manganese	0·97
Cobalt and Phosphorus... ...	traces
Copper	0·03
Carbon	1·67
Bituminous Hydrocarbon ...	0·25
Sundries	1·22
	100·00

Another fact in connection with these aërolites is also very interesting, which is that many of them contain a large amount of iron, and spectrum analysis proves to us that this metal is as abundant in the Sun and Stars as it is in the Earth. Take as an illustration the following analysis by Wichelhaus of a meteorite found at Santa Rosa in Mexico :—

Iron	96·072
Nickel	3·263
Cobalt	0·550
Phosphorus	1·046
	100·931

I have thus endeavoured to show the results of those grand and wondrous laws which were first called into operation when the Divine fiat went forth—"*Let there be Light.*"

Velocity of Light.

I have often thought the calculation of the rapidity with which light travels a masterpiece of human reasoning. To

catch a sunbeam and record the rate of its velocity seems but little short of a miracle; and yet it has been done, and I will tell you how.

Please then to look at my diagram in reference to meteors (Plate I., page 50), and you will see that Jupiter has four moons, the distances of which from the planet, and the periods of their revolution, are as follow :—

Order.	*Distance from Jupiter.*	*Revolution.*
I.	267,000 miles,	1 day 18 hours 29 min.
II.	425,000 „	3 days 13 hours 18 min.
III.	678,000 „	7 days 4 hours 0 min.
IV.	1,193,000 „	16 days 18 hours 5 min.

Now Römer, a Danish astronomer, soon after the discovery of the telescope, was engaged in a series of observations, the object of which was to ascertain the exact time of the revolution of these bodies round Jupiter. The mode in which he proposed to investigate this was by observing the successive eclipses of the satellites, and noticing the intervals of time which occurred between these eclipses.

For several months did he watch the planet, and accurately observe after each revolution the moment that a satellite entered the shadow or emerged from it. From these observations he was able to calculate exactly the motions of the satellites, and to compute a table in which the time of every eclipse for twelve months in advance was predicted. He was surprised to find, however, a remarkable systematic discrepancy, amounting to as much as 16 minutes 35 seconds when the Earth was on the side of its orbit farthest from Jupiter, at the time of an eclipse of one of the satellites. The happy thought struck him that this was due to the time occupied by light in travelling *across the Earth's orbit*, that is to say, it passed over nearly 186,000,000 miles from E to E′ (Plate I.) in 16 minutes 35 seconds, or rather more than 186,000 miles in one second.

At this rate it takes about 50 minutes travelling *from the*

planet to E′, therefore when in that position we do not see the eclipses until nearly an hour after they have really taken place.

This discovery of the velocity of light, remarkable as it was, did not at first find favour in the scientific world; but it has long since been accepted, and recent optical experiments have quite confirmed Römer's theory. It may aid you to grasp the idea of this rapidity when I say that if you had wings and could fly with the velocity of light, you would be able to pass seven times round the Globe before a clock beating seconds would tick twice.

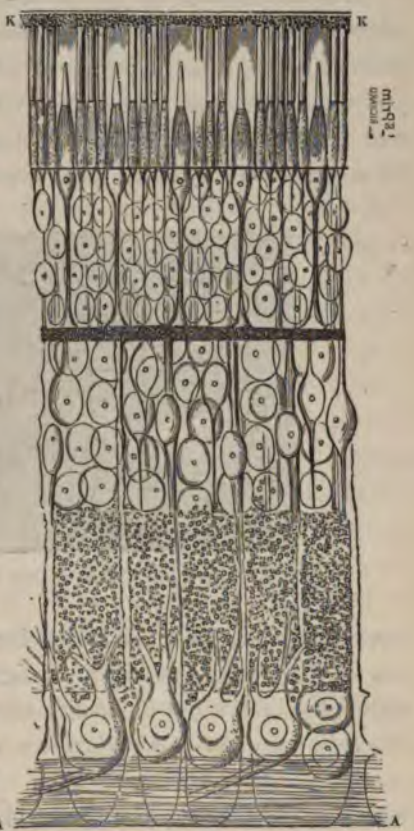


Fig. 13.—Highly Magnified Section of the Human Retina.

I have, however, greater marvels still to tell you in reference to light. At the back part of the eye the delicate membrane of the retina is spread out, which is an expansion of the fibres of the optic nerve. Though only $\frac{1}{80}$th part of an inch in thickness, it is composed of no fewer than ten different nervous layers, and each layer, therefore, is only the $\frac{1}{800}$th of an inch in thickness. These delicate structures are absolutely essential to enable light to give that stimulus to the optic nerve which conveys to the brain visual sensations. Fig. 13

will give some idea of this beautiful apparatus. It must be particularly noted, however, that the distance from A to K is only the $\frac{1}{80}$th of an inch.

Newton showed by means of a prism, P (Fig. 14), that white light was composed of seven colours, H, I—red, orange, yellow, green, blue, indigo, and violet—red being the least, and violet the most refrangible. The experiments of Young and Fresnel have since proved that each colour is produced by a series of undulations or waves, the lengths of which

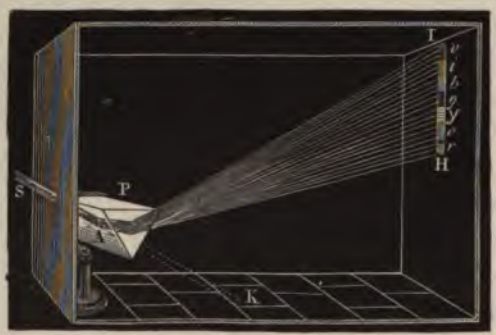


Fig. 14.—Refraction of a Ray of Light by a Prism.

have been measured. The number of waves in one inch of red light are 40,960, and as light travels at the rate of about 186,000 miles a second, the number of vibrations of the retina in a second when we are looking at a red rose would be 514,000,000,000,000! In the violet rays these waves are much smaller, there being 60,040 in an inch; therefore the number of vibrations of the retina when we look at a bunch of violets are 750,000,000,000,000!

To conceive of such a small division of time is certainly beyond us; nevertheless, something is actually done in the 750-billionth of a second, for the delicate nerves of the retina vibrate as many times in a second as a watch would tick in twenty-two millions of years. Does not this give us a glimpse

of the infinite power of the Creator, who could make a piece of mechanism seven hundred and fifty billions of times more delicate than the escapement of a watch?

And now, before concluding this chapter, I must give you a short account of Spectrum Analysis, to which I shall frequently refer; and in order to lead you up to the subject I would ask you to make one or two little experiments.

First put into a little metal dish some salt and cover it over with cotton-wool, adding some more salt until every part of the cotton-wool be hidden, and then pour upon it some *pure* alcohol until it be fairly saturated. On turning the gas down, and setting light to the contents of the dish, you will find everything changed; a bouquet of flowers, with its variety of colours, will lose all its beauty, and show only several shades of grey and white. A painting with its bright colouring will appear like an engraving or a monochrome. All the ribands and flowers on the ladies' dresses will lose their pleasing gaiety, and, worse than all, their cheeks will look as pale and ghastly as though they had been suddenly panic-stricken, only the merry laughter throughout the room will belie the idea. What will all this mean? Simply that the light you will produce will have but one colour in its composition, viz., yellow, whereas the light of the Sun is composed of seven colours. Salt being the chemical union of the metal sodium and the metalloid chlorine, some of the sodium will be sufficiently heated to become a gas; and this gas being ignited by the flaming spirit will result in the strange phenomenon of light without any apparent colour.

Now take some nitrate of strontium, and having poured over it some alcohol as before, on setting fire to it you will have a glaring red flame, making everything glow with a ruddy tinge. On doing the same thing with a salt of barium, the rosy hue will be turned into a pale green.

After amusing yourself and your friends with these

scientific fireworks, if you will allow the light of each of the flames to pass through a prism, you will find that the sodium flame will throw upon a white sheet a spectrum having only a yellow band; the strontium will throw upon it several different-coloured bands, of which red will be the chief; and the barium will give a number of bright green bands and several red ones. On your compounding these three metals together, and burning them in a similar manner, you will have a spectrum showing all the bands of each without one overlapping another. So delicate is this test of the presence of a metal, that the hundred-millionth of a grain of sodium can by this process be detected.

This, then, is the basis of Spectrum Analysis; for, by passing any light whatever through a prism, we can, by noticing the various bands of colour, at once read off upon the spectrum what metals and metalloids are in a state of combustion to produce that light.

I must mention, however, that in the spectra of incandescent solid and liquid bodies, the continuity of the coloured light is sometimes broken by dark lines. These dark spaces are not produced by the source of light, but they tell us of vapours through which the light has passed on its way, and which have robbed the light by absorption of certain definite colours. Kirchhoff has shown that these groups of dark lines are produced by the vapour of the incandescent body, and that the number of lines and their position in the spectrum is identical with the group of bright lines of which the light of the vapour consists when it is luminous. Thus, let the light of a piece of sodium be thrown through a prism on to a white screen, it would produce, as I said before, a bright yellow band, or rather several very close together; then let the vapour of another piece of sodium intervene between the light and the prism, and we should find that a dark line would be produced just exactly over the bright yellow lines.

Fig. 15 is a picture of the Solar Spectrum (uncoloured, but the colours are indicated verbally below it), with the chief dark lines, or missing tints, noted by Fraunhofer. I say chief, because between each of these lines there are many others which are fully described by Schellen, Proctor, Lockyer, and others.

It is these dark lines, then, that have enabled us to analyse the light of the Sun, Stars, and Nebulæ, and to ascertain what substances there are in them in a state of incandescence. Amongst those in the Sun we know that there are sodium, calcium, barium, iron, magnesium, chromium, nickel, copper, zinc, strontium, cadmium, cobalt, hydrogen, and some others.

Fig. 15.—The Solar Spectrum, showing the Fraunhofer Lines.

In the star Aldebaran, in the constellation Taurus, the following metals have been discovered:—Hydrogen, sodium, magnesium, calcium, iron, bismuth, tellurium, antimony, mercury, and others.

Is not this indeed one of the greatest marvels, nay, miracles, of inductive science? Little did Sir Isaac Newton think, when he bought a prism at the fair, how much it would enable him to learn of the nature and properties of light; and if he had been told that that simple instrument would afterwards become the revealer of the composition of Suns and Stars, even he would have doubted the sanity of such a prophet; and though during his experiments he must have seen the dark lines to which I have alluded, yet he would no more have understood the language written in those legible characters than his scholarly contemporaries could

understand the Assyrian cuneiforms or the Egyptian hieroglyphs now so easily read by our Birches, our Smiths, and our Rawlinsons.

The apparatus used for Spectrum Analysis, as now made by Mr. Browning and other opticians, is very beautiful and very delicate in all its parts; Fig. 16 is one of the simplest forms, and Fig. 17 a more elaborate one with six prisms.

When I first saw through the Spectroscope invented by Kirchhoff and Bunsen for this new science, my sensations

Fig. 16.—The Student's Spectroscope.

were indescribable, as it filled me with delight, and I exclaimed, "Man's soul must indeed be a spark of divinity!" For, only a little while before, Science had in the electric telegraph annihilated time, and now spaces bordering upon the infinite had been bridged over, and the materials of which stars are composed accurately ascertained, though it would take millions upon millions of years to reach such stars even by the swiftest means of locomotion known to us.

And now, in conclusion, let us consider why it has been ordained by the Creator that incandescent substances should produce such a variety of colours, and why so many of them should enter into the composition of the Sun. You have seen

the effect of the combustion of sodium: what a miserable-looking world it would have been if the Sun had been composed of that metal only! Fancy the monotony of only light and shade! Or suppose strontium or lithium had been there in excess, how glaring would have been the fiery colour of everything! More wise was He who designed it all. He com-

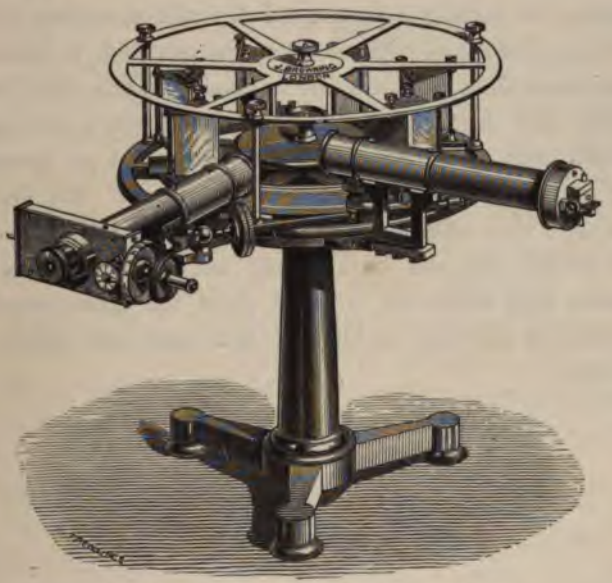


Fig. 17.—Spectroscope with returning Beam.

mingled together these bright colours so harmoniously that white should be the product; and then He gave to various substances capabilities of absorption and reflection, so that our gardens, our fields, our houses might abound in every variety of hue.

An exquisite engraving gives us much pleasure, but it does not equal the gratification afforded us by looking at a beautiful painting. In the one case, we have form and shade only; in the other, form, shade, and colour.

Let us imagine ourselves conducted through an exhibition of such paintings by the child of an artist. Would not the little one prattle in extollation of its father's skill? So let us, when walking through the picture-galleries of this beautiful world, exclaim, Our Father made them all! And when we are viewing the lovely parterre, the glorious landscape, the towering mountain, the diamond drops of dew, the glittering cascade, the rushing cataract, and the wide-spreading sea, let us lift up our hearts with adoration and gratitude to Him who made them all so beautiful and so good! When, also, we are gazing with admiration at a cloud upon which the seven-coloured arch is glowing in all its beauty, let us remember that it has been placed there as a token of His love, to be a sign that seed-time and harvest, cold and heat, summer and winter, day and night, shall not cease. And as it is written that a rainbow is round about the throne, surely it is there as a further emblem of that same love existing in Heaven.

CHAPTER III.

"Let there be a Firmament."

Let us try to picture to ourselves the holy prophet seated on that mountain-top in a complete ecstasy at the wondrous display he was witnessing of the brilliant outburst of light, occasioned by the first formation throughout space of Suns and Stars innumerable. He gazes with intense admiration, and his whole soul is filled with devout aspirations whilst he hears the voice of God proclaiming it to be all very good. As he bows his head with humble reverence before the majesty of Deity, the glorious panorama is veiled in darkness, leaving him rapt in contemplation of the power and perfection of the Creator.

The mist clears, and again it is light. Moses looks out upon the scene, and notices that the Earth has assumed a definite form, that it is now encased with water, and that there is an atmosphere separating the universal ocean from the vaporous clouds that float above it.

Much, however, had taken place since the scenes described in the last chapter, and ages had intervened; but during those æons the divinely-appointed laws of Nature were bringing about the results which I shall presently relate: I will, however, just notice that *Firmament* is the Latin translation of the Greek work στερέωμα, wrongly introduced into the Septuagint version. Although the Egyptians thought that the sky was a solid canopy, in which were placed the Sun and Stars, and although Moses was educated in the Egyptian

schools, and took care to teach the Israelites in phrases familiar to them, he did not use a word signifying *Firmament*, but רָקִיעַ (*rākfang*), meaning "an expanse," from the verb רָקַע (*rākang*), "to expand," "to stretch out." According to the Talmud, Treatise *Haguigah*, folio 12, page A, it would signify "an expansion," and these very ancient writings go on to say that "When God created the world it continued to expand until He rebuked it." Or, in other words, He ordained a series of laws which should bring about a succession of events until He should cause them to cease.

It seems quite evident from this passage in the Talmud that the old philosophers and divines understood far more of the operations of Nature than is generally supposed. Delgado also translates this passage, "*And God said, Let there be an expansion.*"

I might here mention that when I first commenced this work I thought I would in the same chapter describe the physical phenomena together with the flora and fauna of each period; but I soon found that it would be better that these subjects should be treated separately, and in different chapters. This plan, however, will not interfere with the chain of events, as will be seen in the sequel.

In the present chapter I shall continue a description of the great processes which took place after the Earth had been formed by the accretion and condensation of nebulous and meteoric matter, and shall also give an account of the various meteorological phenomena of past and present times.

In my introductory chapter I have referred to the difference of opinion between Sir John Lubbock and Prof. Henry Hennessey, Dean of the Royal College of Science, Dublin, respecting the thickness of the Earth's crust; the former regarding the Earth as practically solid, the latter as surrounded only by a comparatively thin crust. The subject

was only just alluded to in Sir John's very comprehensive address to the British Association at York, but his remarks embodied the published views of Sir W. Thomson, Prof. P. G. Tait, Prof. Clerk Maxwell, and others. On the other hand, Prof. Hennessey has made it for years one of his special studies, and I think the scientific world will in the discussion award the palm to the Dean, who is backed up in his theories by a large proportion of eminent scientific men throughout Europe, and whose opinions I have always entertained; indeed, a great portion of this chapter was written by me some months before the York meeting.*

Reasoning from what we know of the present heat of the Earth, we can arrive at some approximation to its heat at the early period of its history related in the last chapter, some philosophers estimating it at many times greater than what would melt all the known rocks and metals. Remarkable as this statement may seem, it is very easy to see how the calculation has been made.

In 1740, Gensanne noticed that the temperature in the lead-mines of Germany increased as he descended in depth. Saussure afterwards observed the same in the salt-mines of Bex, in Switzerland. This fact having been reported, the *savants* of the day made several important experiments in other mines; and those of the Vosges being tested, it was found that at the surface the mean annual temperature was 49°, and on descending there was a rise in temperature of 1° Fahr. for about every 60 feet. In Saxony the average increase was 1° Fahr. for every 66 feet, and in Britain 1° Fahr. for every 45 feet.

From this it is evident that the heat increases in proportion to the depth, but that it varies in different places. Humboldt, after having executed an extensive and interesting

* An admirable letter from Professor Hennessey upon this subject will be found in *The Times* of Sept. 7, 1881.

series of experiments in the mines of Freyburg, came to the conclusion that the average rise of the mercury was about 1° Fahr. for every 52 feet.

In connection with these experiments, Count de Cassini, in concert with Lavoisier, in 1783, placed a very delicate thermometer in one of the caves under the Observatory of Paris, for the purpose of ascertaining the point where the instrument would remain stationary and unaffected by the outer atmosphere or the internal heat of the Earth; and they found this point 90 feet below the surface; and there, for almost a century, has this thermometer, embedded in fine sand, remained stationary at nearly 12° Cent., or 53⅗° Fahr. —in exact figures, 11·82° Cent., and 53·276° Fahr. It is so extremely sensitive to changes of temperature as to allow the measurement of what would be equivalent to the one-hundredth part of a degree on Fahrenheit's scale.

This, therefore, was the starting-point in Paris, and a little further down the thermometer began to rise, which, with numerous other observations, confirmed Humboldt's calculations. In the British coal-mine at Rosebridge, near Wigan, 2,445 feet deep, the average increase of temperature is 1° Fahr. for each 54·3 feet.

At the meeting of the British Association at York (1881), Professor Everett read the report of the "Committee on the Underground Temperature," and said that during the past year observations had been made in three places—at the East Manchester Coal-field; the Talargoch Lead-mine, in Flintshire; and at Radstock Collieries, in the neighbourhood of Bath.

In the Manchester mine they were able to go down to the great depth of 2,790 feet, where the temperature was 85·3°. Assuming the surface temperature to be 49°, the increase was 36·3°, or 1° Fahr. in 76·9 feet.

In Flintshire, with a surface temperature of 48°, an

increase of 14° was shown in 660 feet, or 1° in 47 feet; whilst in three mines near Bath the average increase was 1° in 62 feet. Other depths were mentioned, but these instances will suffice to show that the average increase is about 1° for every 50 or 60 feet.

According to this ratio the hot springs of Bath, which are 113° Fahr., probably come up from a depth of three-quarters of a mile; and boiling springs, unless heated from local causes, would come from two miles below the surface. Following this reasoning, at thirty miles down the temperature must be 3,630°, quite sufficient to fuse all the known rocks and metals; for platinum, the most refractory of metals, melts at 3,082° Fahr.; therefore, the heat of the Earth at its centre now, and of the whole globe during the period which is occupying our attention, would probably be far greater than that which would melt granite.

And then, Figuier in "The World before the Deluge," says, the metals, the chlorides, the sulphides, and even the silicates of alumina and lime, would exist in a gaseous form; also the enormous body of water constituting our oceans, seas, and rivers, would be in a vaporous condition; added to these, the component parts of air—nitrogen, oxygen, and carbonic acid—would swell the atmosphere to such an extent, that it must have extended a thousand times farther into space than it does now.

Under these circumstances the different substances composing such an atmosphere would at first be ranged round the Earth in the order of their respective densities; that part of it nearest to the molten globe being formed of the heavier vapours, such as those of the metals, iron, platinum, copper, &c.

This first and heaviest zone would be the thickest and probably partaking of the incandescence of the Earth, which was at that period considerable.

The next layer might consist of the more vaporisable sub-

stances; such as the metallic and alkaline chlorides of sodium, potassium, sulphur, and phosphorus, with all their volatile combinations.

The upper zone might contain matter still more easily converted into vapour; such as water, with the gaseous compounds of oxygen, nitrogen, and carbonic acid.

This order of superposition would not, however, be long preserved. In spite of their differences of densities, these atmospheric layers would become mixed by diffusion, also formidable storms and violent ebullitions would frequently confound these incandescent zones.

As to the globe itself, without being so much agitated as its hot and stifling atmosphere, it would be no less subject to perpetual tempests occasioned by a thousand chemical actions which were taking place in its molten mass.

In this manner would our globe circulate in space, carrying in its train the flaming streaks of its multiple atmosphere, unfitted as yet for living beings, and impenetrable to the rays of the Sun.

This atmosphere of many elements in a condition of vapour would considerably retard the cooling of the Earth; for the heat would not readily be radiated into space through so dense an atmosphere, and would be partly reflected back, as I shall explain further on when speaking of dew. Still the time would come when the Earth would gradually cool; for, whilst it was proceeding along its orbit of some 500,000,000 miles, its heat would be slowly radiated into planetary space, the temperature of which is probably about $-220°$ Fahr. (or 252° below the freezing-point of water), this being the mean of three independent estimates by Sir John Herschel, Pouillet, and Frölich.

Revolving also upon its axis in its molten condition, the Earth's liquid fires would be subject to the diurnal attraction of the Sun and Moon; and, therefore, a tidal wave of molten

matter would rise and fall as the sea does now, which would help to accelerate the cooling of the surface. Nevertheless, age after age must have rolled away, yea! æons of years must have passed before the first rocky crust was formed, and then it must have been very thin and still very hot.

In my subsequent descriptions of the stratified portions of the Earth's crust I shall be guided by what geologists have learned from the records still existing in the rocks; but of those earliest formed and deposited from the primeval ocean long before life existed, we know nothing. Nor do we know anything certainly of the rocky nature of the primitive crust.

It used to be supposed that granite rocks were the first formed, and that all granites were of this ancient date; but now there is good reason to believe that granite has been formed at various periods of the Earth's history. Lyell, Ramsay, Sorby, and many other eminent geologists, state that the granites must have been formed under immense pressure and with the presence of water, as the fluid found in cavities distinctly proves.

We must not therefore always speak of granite as the oldest of the rocks. There are granite formations which are not so old as the Silurian, and some are perhaps of comparatively recent geological age; but I think that the most ancient granite might have been formed before any of the sedimentary rocks, when the pressure of the surrounding atmosphere was enormous. One writer states that it could not have been less than 15,000 pounds, or seven tons per square inch. Some idea of this pressure may be formed by considering that it would be equal to 12,000 tons' pressure upon the surface of a man's body.

But, whatever its nature may have been, on the rocky surface, at first smooth and unbroken, there would be formed swelling eminences, hollows, foldings, corrugations, and curves, which would materially alter the Earth's original

aspect; its arid and burning surface would bristle with rugged protuberances, or be traversed by enormous fissures or cracks.

As it continued to cool, a time arrived when its temperature became insufficient to maintain in a state of vapour the vast masses of water which floated in the atmosphere. These vapours would pass into a liquid state, and then the first rain fell upon the Earth; this downpour, however, would probably be considerably hotter than boiling water; for with such an atmospheric pressure watery vapour would become a liquid at a temperature much above 212° Fahr.

Let me here explain that, with the barometer at 30 inches at the sea-level, water will not get hotter in an open vessel than 212° Fahr.; and at the summit of Mont Blanc, 15,797 feet high, where the barometer would stand at 16½ inches, the water will not get hotter than 185° Fahr.

An amusing incident in relation to this occurred at the top of Mont St. Bernard, 8,185 feet high, when a party of gentlemen tried to cook potatoes, and could not; for although the tubers were boiling for hours, and left in the water all night, they still remained hard. The cause of this was, that as soon as the water boiled, it would not get any hotter than 198°, which was not a sufficient heat to cook the refractory potatoes. Such troubles may always be got over by hermetically sealing the vessel, and then, if it be strong enough to bear the excessive pressure, you can raise the water at any place even to 1,000° and upwards.

According to an hypothesis by Sir Humphry Davy, the first effect of the precipitation of aqueous vapours upon the Earth would have been, not an inundation, but a conflagration, a vast outbreak of fire enveloping anew the globe as yet scarcely cooled and solidified.

This fire would have burst forth when the liquefied vapours came into contact with the metals potassium, sodium, &c., which decompose water at the ordinary temperature, and are

so light that they would probably be distributed over the surface of the still hot globe.

M. Arthur Mangin, in his popular work "Les Mystères de l'Océan," graphically thus describes the first formation of the universal sea:—Gradually these lurid flames would subside, and then the water having given up its oxygen to these metals, they would become alkalies and earths. The hydrogen being set free, however, would again unite with the oxygen of the atmosphere, and, as a highly-heated vapour, would ascend to the top, where, coming into contact with the glacial regions of space, it would be condensed and fall again upon the Earth; but as time went on there would be no conflagration, for, on coming into contact with the still heated rocks, the water would re-ascend as vapour. This might take place many times; but each time the Earth would become cooler, for each time much heat would be withdrawn from the surface of the globe, and at last the waters would settle down and form a universal ocean, boiling and seething and assimilating all the soluble matters of very diverse natures, particularly the soda, potassa, ammonia, magnesia, and even the vitrified and agglomerated metals, which would be violently stirred and upheaved by the hot, thick, troubled water—a sort of witches' broth, wherein all the liquid and solid elements boil over the central furnace. By degrees the gases in their turn would be dissolved in the ebullient flood, so that nearly all the bodies in Nature would be present and react upon each other with the whole energy of their affinities and their mutual repulsions.

In fact, the globe would be a mighty caldron where the Divine chemistry was elaborating the materials of its ultimate condition. All this, also, would have disengaged vast quantities of electricity, so that these early throes of Nature would be accompanied by vivid flashes of lightning and loud and continued thunder.

I mentioned just now that, in cooling, irregularities would appear on the surface, forming the earliest mountain-chains, valleys, rents, and ravines, according as the various parts of the surface might radiate heat in an unequal manner. Over these early mountains and ravines the boiling ocean would dash and the hot rain would fall, causing a disintegration of the rocks, which, after being suspended for a short time in the water, would be deposited at the bottom of the sea. In this manner, we have strong grounds for believing, the first stratified rocks were produced.

What these first stratified rocks were, and where they may now be found, are questions which cannot be answered with certainty. In the older days of Geology there would have been no hesitation as to the reply. The gneiss, mica-schist, and similar rocks were then always regarded as the first-formed of the stratified series.

In later times this opinion fell into disrepute, and geologists came to believe that much of the gneiss was of comparatively modern date—that, in fact, it was ordinary fossiliferous sedimentary rock, altered by central heat. To a very large extent, however, geologists are now falling back on the older views; and there is a very general feeling that gneiss, wherever it may occur, is probably the oldest of the sedimentary rocks.

Granting that in many cases gneiss may be only an extreme form of alteration or "metamorphism" of ordinary sedimentary rock, we may still suppose that some of this widely-spread formation may be part of the first-formed rock of which we are in search.

The origin and mode of formation of mineral veins is one of the many subjects in Geology on which much is yet to be learnt. Veins or lodes are cracks running through the rocks, along which various metallic and other minerals are arranged in definite and parallel bands. From the nature

of the minerals we know that, in most cases, the lode must have been formed by the slow action of water, perhaps highly heated and charged with mineral matter. But there is evidence that the nature of the lode varies according to the rock through which it runs, and there is good reason to believe that, in many cases, the metallic matter has been slowly extracted from the great mass of the surrounding rock.

There is a very interesting fact in reference to the gneiss, which is, that almost all the metals are met with in it in veins; and I do not think I should be far wrong in supposing that many of the metals were in solution in the primeval ocean. Some of them still remain in the sea, and though in very small quantities can be detected by ordinary chemical analysis, or can be elaborated from the sea-water by the most exquisite physical processes; amongst these metals are iron, gold, silver, and copper.

A short time since a striking calculation was made in reference to the amount of silver in the sea. Some copper which had been for a great while on the bottom of a ship was found to have some silver precipitated upon it in such quantities that an estimate might be made of the amount in solution in the sea; and it was found that if by any process this amount could be precipitated and collected into a separate mass, it would weigh 200,000,000 tons. Gold also occurs in sea-water; the amount is estimated at one grain of the metal in each ton of water.

Gneiss is found widely distributed over the Earth; for hardly any considerable mountain-range occurs without it. Not much, however, is found in England and Wales; but in Scotland it occupies an area estimated at 9,600 square miles.

It is impossible to make an accurate approximation to the thickness of these groups of old and unfossiliferous strata, for the overlying masses prevent their being adequately explored,

and cause our surveys to fall short of the full amount as to magnitude. But sufficient evidence is obtainable to vindicate from the charge of exaggeration an estimate of the thickness of these systems at several thousands of yards, nay, even at several miles. An enormous demand is made upon time for the production of these immense beds, the sedimentary origin of which is proved by the water-worn aspect of their component ingredients, their leaf-like arrangement, and lines of stratification. To disintegrate to any considerable extent a solid rock, to deposit it and consolidate the deposition, are excessively slow operations, requiring the lapse of centuries to form even a thin stratum.

How many ages, then, must it have taken to build up these gneissic and mica-schist systems, some miles in thickness, by the abrasion of the primitive crust and the gradual deposition of the detached matter at the bottom of the ocean! The mind can hardly grapple with the vastness of the period required, though it would be perfectly insignificant to Him to whom thousands of years are but as moments of time. These laws are in operation now as then, and the same changes are still as gradually and continually going on.

Composition of the Rocks.

I cannot resist the temptation to say a few words here upon the composition of some of the Rocks.

In popular language the word *rock* instantly suggests the idea of a huge, compact, and hard substance. This is not the geological signification of the term. It is applied to every kind of formation which constitutes the crust of the globe; from the loose sand and gravel of our pathways, and the soft clays that lie beneath the surface soil, to the close-grained, heavy, and majestic masses of granite, gneiss, &c., that form the highest Alps, or that crown the summit of the Andes. These materials, so various in texture and diverse in form, are

found upon analysis to be compounded of a very few elementary substances; for chemistry, which like all science takes us back from the most complex results to the most simple causes, has now been brought to a great state of perfection.

The number of known simple or elementary substances —that is, those out of which hitherto it has been supposed that nothing different from themselves could be obtained— amounted in the year 1787 to seventeen, in 1802 to twenty-eight; the number at present known is upwards of sixty. But from sixteen to twenty simple substances are all that go to form these towering mountains with their sweeping valleys, the stately forests and the flowers of the field, the winds that blow and the waves that roar.

Even of this reduced number there are only about eight which are of great importance. The following estimate of the composition of the Earth's solid crust is from Roscoe's "Lessons in Elementary Chemistry." It gives the probable average proportion in each 100 parts by weight:—

Oxygen	44·0	to	48·7
Silicon	22·8	„	36·2
Aluminium	9·9	„	6·1
Iron	9·9	„	2·4
Calcium	6·6	„	0·9
Magnesium	2·7	„	0·1
Sodium	2·4	„	2·5
Potassium	1·7	„	3·1

One of the most important, most abundant, and hardest substances in the formation of rocks, is quartz. It forms independent mountain-masses; occurs in veins intersecting mountains; also as flint, chalcedony, rock crystal, and sandstone; is a constituent of granite; and is found in some vegetable productions, as the stalks of reeds and the outer coating of bamboo, which will strike fire with steel. The white glassy crystals of granite and the grains of sandstone are quartz.

Next to quartz the silicates of alumina and lime are of the highest importance; they form the felspars of the crystalline rocks, whilst the first-named mineral forms the clays of the sedimentary rocks. Another abundant mineral is carbonate of lime, which consists of lime and carbonic acid. It exists in great purity in Carrara and other statuary marbles; it is diffused in nearly all waters in the form of bicarbonate of lime; it forms chalk, and limestone of various degrees of hardness, and the shells of most molluscs. Lime combined with phosphoric acid, or phosphate of lime, enters largely into the composition of animal bodies (forming the solid parts of bones and teeth), and is also an essential constituent of vegetables.

Of all the metals iron is most generally diffused; it occurs abundantly as an oxide and as a bisulphide (iron pyrites), the latter being the bright brass-like spangles which we often see in coal.

Carbon, in the form of *coal*, occurs abundantly in some rocks; but taken altogether it forms only a very small proportion of the Earth's crust. Graphite is composed mainly of carbon. This mineral is found in great purity in the mines of Borrowdale; it is sometimes called "blacklead," although there is no lead in its composition.

Some of these simple rocks and metals have by marvellous chemical processes been transformed into gems so beautiful and so varied, that we gaze upon them with intense pleasure. The diamond, outrivalled by nothing in Nature for its hardness, its clearness, and its sparkling brilliancy, is only a piece of pure carbon, or charcoal crystallised.*

The valuable ruby, equalling it in beauty of another kind, and nearly as hard in its texture, is but pure alumina with about one per cent. of chromium. Now alumina is one of the ingredients of clay, therefore the lovely ruby may be compared to a piece of red brick in another form.

* See Appendix (p. 465) for further information respecting diamonds.

The charming blue sapphire also is composed of nearly pure alumina, with a very small quantity of cobalt, a different arrangement of its atoms or a slightly increased proportion of the cobalt probably causing its variety of colour.

The emerald, a silicate of beryllium and aluminium, which was a very favourite stone amongst the ancients, is composed of substances which abound in the commonest rocks, such as silica, alumina, chromium, iron, lime, &c.

The lovely opal, with its ten thousand variations of colour, and its iridescence rivalling the rainbow, is only pure silica and water—viz., 90 per cent. of the former and 10 per cent. of the latter; a piece of common flint, therefore, differs but little in composition from this charming gem.

The pearl, too, of such a soft whiteness, so delicate and so valuable, is but carbonate of lime, or chalk in another form.

Thus has God made many things in the world very beautiful. Had He only considered our necessities, the simple rocks and metals suitable for materials for our buildings, our roads, and our machinery would have been all that we should really have required; but He has been good as well as wise, and has given endless things to gratify our senses and to send through our hearts a thrill of pleasure and delight.

To those of my readers who desire to know more about Precious Stones I can recommend Mr. Streeter's excellent work, which is written in a very popular and interesting style.

I must here notice an important fact, that oxygen enters largely into the composition of nearly all the rocks, and, as we have already seen, they probably thus combined with it when in a state of great heat.

It is estimated that oxygen constitutes nearly half the entire crust of the globe, and more than one-half of living plants and animals.

It is very clear that the stratified and unstratified rocks have been formed under the operation of totally distinct causes. The parallel arrangement of the strata, the pebbles of pre-existing rocks, and the organic remains embedded in them, together with the ripple-marks, the foot-prints, and other traces of animals which they exhibit, demonstrate their de-

Fig. 18.—Veins of Granite traversing the Gneiss of Cape Wrath.

position in water; while the clear marks of having crystallised in cooling from a state of fusion borne by the unstratified rocks, the close analogy of their composition to modern lavas, and often complete identity, plainly prove their igneous origin.

In considering the association of the two classes, the most decisive evidence appears that while the unstratified masses are found beneath the stratified, they have often been violently propelled among the strata in a melted state. It is

obvious that the materials of the sedimentary rocks must have been deposited almost horizontally; yet nothing is more common than to see beds of sandstone and conglomerate in a vertical position.

As a penetrated body must have an existence prior to its penetration by another body, it is plain that, where limestone is penetrated by veins of granite, the limestone was formed prior to the intrusion of the granite; while it is equally clear that by thus overlying and interstratifying the limestone and forming veins, the granite must have been erupted in a melted condition. Fig. 18 is an illustration of this, showing the veins of granite traversing the gneiss of Cape Wrath. A remarkable change is often observed in the character of the sedimentary strata in immediate contact with the granite or any other igneous rocks, arising from exposure to the action of the heated mass.

The celebrated Carrara marble used in sculpture, once supposed from the absence of fossils and from its crystalline texture to be a primitive rock, is only a limestone of a comparatively modern period, the fossils of which have been destroyed, and the whole changed into a uniform rock.*

The Universal Ocean.

In the 104th Psalm we find in few words all I have said about the primary rocks being of a strong and lasting character:—

"*Who laid the foundations of the Earth, that it should not be removed for ever.*" (Verse 5.)

And then the formation of the water is thus described:—

"*Thou coveredst it*" (that is, the Earth) "*with the deep*

* There is a splendid collection of precious stones and minerals at the New Natural History Museum, South Kensington, excellently arranged by Mr. L. Fletcher, M.A., which I advise every one to visit. (See p. 472.)

as with a garment: the waters stood above the mountains." (Verse 6.)

Here is precisely the early condition of the Earth: the waters encased the whole globe and were above the early mountains, which were formed by the corrugations and contortions caused by the shrinking of the crust of the Earth as it cooled.

Who will dare, after this quotation, to say that the Bible is not in harmony with Science?

Bishop Lowth, in different lectures, refers repeatedly to the magnificent composition of this Psalm, which is evidently a recapitulation of the various acts of creation, and he says:—

"The 104th Psalm demonstrates the glory of the Creator from the wisdom, beauty, and variety of His works. The poet embellishes this noble subject with the clearest and most splendid colouring of language, and with imagery the most magnificent, lively, diversified, and pleasing, at the same time select and happily adapted to the subject. There is nothing of the kind extant; indeed, nothing can be conceived more perfect than this hymn, whether it be considered with respect to its intrinsic beauties or as a model of that species of composition."

Humboldt used to speak of this Psalm as his Cosmos, and it is generally admitted that David wrote it, which is a very interesting circumstance, for he must have had very clear views of creation, and all through this splendid composition he confirms the theories I am endeavouring to put forth in this work.

The entire quantity of water existing, whether as vapour, fluid, or solid, can be pretty well estimated; and therefore we know that this universal ocean must have been about two-and-a-half miles in depth, whereas now that it covers about three-fourths of the surface it varies in depth from a few feet to over five miles. Were all these waters collected together, so as to form a sphere, it would be 900 miles in diameter, and about $\frac{1}{4000}$th the weight of the Earth.

It will be remembered that I called attention to the circumstance that sodium, potassium, calcium, and the lighter elements would be on the top of the cooling rocks; therefore when the first rain descended it would combine with these metals immediately, and the water would thus become impregnated with saline substances. The long-continued action of rain upon the rocks would also help to make the sea salt; for all lakes which have no outlet are salt. The following analysis of 1,000 grains given by Schweizer will show what these salts are, and in what proportion they enter into the composition of sea-water taken from the British Channel :—

Water	963·74
Chloride of Sodium	28·05
,, of Magnesium	3·66
,, of Potassium	0·76
Iodide and Bromide of Magnesia ...	0·02
Sulphate of Magnesia	2·29
,, of Lime	1·40
Traces of Iodine, Ammonia, Ferric Oxide, and Carbonate of Lime ...	,,
Leaving a residuum of	0·08
	1,000·00

Captain Maury states that the quantity of salt in the sea, if collected, would form a mountain the base of which would cover the whole of North America and reach a mile in height; this would be 7,500,000 cubic miles.

Clouds and Mist.

There are different opinions in reference to the meaning of "the waters above the Firmament," but I do not think we should be far wrong in concluding that the vaporous clouds floating in the higher regions of the air are referred to; for in this primeval sea the evaporation must have been considerably more than at present. In reference to this evaporation

we have been furnished with some interesting calculations by Dr. Halley. He made a number of experiments at St. Helena as to the quantity of water that is daily evaporated from the sea, and he found that ten square inches of the ocean's surface yielded one cubic inch of water in twelve hours—a square mile therefore yields 401,448,960 cubic inches, or about a million and a half gallons of water. From the surface of the Mediterranean Sea during a summer's day there would pass off in invisible vapour a billion gallons of water. This being only for one day, the quantity evaporated in a year would be 365 times greater, and in two thousand years it would amount to seven hundred and thirty thousand billions of gallons, which evaporation would, I think, have quite emptied this sea; but it can be shown that there is as much water there now as in the time of the Romans; therefore the balance is kept up by the downpour of rain, the influx of the rivers, and the currents from the Atlantic.

Now let us consider the amount of power required for all this evaporation. The late Professor Joule, whose experiments have given to the world so much valuable information, says that to evaporate by artificial heat a pool of water one square mile in area and six inches in depth would require the combustion of 30,000 tons of coal; therefore to evaporate all the water that ascends from the Earth would take 6,000,000,000,000 (six billions) of tons, or more than all the coal that could be stowed away in half-a-dozen such worlds as this; and yet silently and surely has the process of evaporation been going on for millions of years.

The water which this great distillery of Nature thus prepares is perfectly pure, containing only the chemical combination of the two gases hydrogen and oxygen (H_2O), and as it expands it spreads throughout the atmosphere, and is invisible until a decline of the temperature or an addition of moisture brings the air to the point of saturation. A cubic

mass of air, measuring 40 inches each way, at a temperature of 68° Fahr. may contain 252 grains of water without being visible, and a large room 120 feet long, 60 feet broad, and 30 feet high, might contain 255 pounds troy of water suspended in the air unseen; but suddenly lower the temperature 10°, and the whole room would be filled with a dense mist. The condensation of this invisible vapour to visible dew by a change of temperature is well seen when a glass of iced water is brought into a warm room. I was very much amused once at a dinner-party by a lady telling me, with quite an amount of philosophical assurance, that this dew was occasioned by the ice expanding the glass to such a degree that the water oozed through its pores; she did not know that the cold water would contract instead of "expanding" the atoms of glass; and yet she was a physician's wife, and must have heard scientific subjects constantly discussed at her own table—so little heed do some people take of what they hear and see.

This little circumstance of the glass illustrates very well the cause of night dew, which is, that when the Sun goes down the Earth radiates its heat into space, and becoming colder, the invisible vapour in the atmosphere is condensed upon the plants, &c. The observations of Wells and Arago have proved that grass on a clear night may be from ten to twenty degrees Fahr. colder than the air, but on cloudy nights there is little or no dew, for the heat radiated from the Earth is reflected back by the clouds.

The passage from the gaseous to the liquid state takes place indifferently at all elevations. When it occurs at the level of the soil it is termed a mist, whereas the condensation of invisible vapour above the Earth is called a cloud. Travelling through the atmosphere in a balloon, the air is simply more or less cold, more or less damp, just as is the case on the surface of the ground, according to the nature of the

mists. A mist or fog, however, is the vapour of water, motionless, passing from the visible to the invisible state, or *vice versâ;* whereas a cloud is a grouping of visible vapours in a given shape, and set in motion by currents of air.

A mist, whether in the form of a cloud or fog, is composed of small bodies of water obeying the laws of universal gravitation by forming themselves into spherules, which Halley and other eminent philosophers thought to be hollow. As water is heavier than air, scientists were for a long time seeking for a good reason to account for clouds floating. I think that Kratzenstein has, however, solved the problem. He was examining in the sunshine some of the vesicles of steam through a magnifying glass, when he observed upon their surface coloured rings like those of soap-bubbles, and some of the rays of light were reflected by the outside surface, others penetrated through, and were reflected by the inner surface; he concluded, therefore, that the envelope of the sphere must be excessively thin to admit of this taking place. We may, therefore, suppose that these vesicles are filled in some way with rarefied air, and are so many little balloons whose height in the atmosphere varies in proportion to the density of the air they contain. How this enclosed air becomes rarefied on the formation of the tiny globule is a problem, I think, still to be solved.

In the second chapter of Genesis it says, "*There went up a mist from the Earth, and watered the whole face of the ground.*" Some people erroneously think this means that no rain fell in Adam's time; but water ascends first from the "*Earth,*" as a visible or invisible mist, before it descends in the form of rain to water the "*ground.*" The difference, Rabbi Ascher says, between the two words is clear; הָאָרֶץ (*hāārĕts*) signifies here both the land and water, and הָאֲדָמָה (*hāădāmāh*) simply the dry land. Rain had fallen millions of years before the creation of Adam.

But I must pass on to give some account of

THE ATMOSPHERE.

It is to the great French chemist Lavoisier, in 1777, that Science owes the discovery of the chemical components of air, which are mechanically mixed. It was not, however, until the present century, or scarcely fifty years ago, that an exact analysis was made by Gay-Lussac and Humboldt, which has since been confirmed by all chemists, and is as follows :—

Oxygen, 23 by weight, 20·9 by volume.
Nitrogen, 77 by weight, 79·1 by volume.

The difference between the ratio of weight and that of volume is due to the fact that oxygen is rather heavier than nitrogen.

There are other gases in the atmosphere, one of which is carbonic acid. The amount of this gas is generally a very small fraction in proportion to the whole, and therefore I have not noticed it in the above estimate. In some districts it abounds in large quantities; for instance, in the Grotto del Cane, near Naples—so called from the cruel experiment of exposing a dog to the poisoned air till he becomes insensible—much of the air is composed of carbonic acid, which makes its way through fissures in the ground, so that an animal breathing the lower stratum of air of this cavern would quickly die. It is said that the Emperor Tiberius had two slaves chained up there, and that they perished at once.

We can learn from this amount of carbonic acid being present in the Grotto del Cane how in former ages the greater heat of the globe, and the large number of crevices which the stratified rocks had not yet covered, contributed considerably to these emissions. Large quantities of this gas became mixed with the aërial fluid, and may have helped

to produce that exuberant vegetation of which we now find the remains in the coal-beds of the Carboniferous period.

Large quantities of carbonic acid are given off also by animals and by combustion. In twenty-four hours a full-grown man inhales 360 cubic feet of air, which combines with the carbon of the blood in the process of respiration; and hence in the same number of hours he breathes out fifteen cubic feet of carbonic acid. Now, if the one-hundredth part of the air be composed of this gas, it becomes very injurious to health, and if 10 per cent. be present it will destroy life, so that we can well understand the necessity for constant ventilation. In a church where 1,200 persons are assembled, 1,500 cubic feet of carbonic-acid gas would be produced in two hours. In the whole of London the carbonic acid produced by animals alone in twenty-four hours is 20,000,000 of cubic feet; and by all the animals and the combustion of fires, gas, &c., no less a quantity than 200,000,000 (two hundred millions) of cubic feet.

These figures are indeed startling, and I might be asked, why are we not all suffocated? The reason is, that though so heavy a gas, yet by the law of diffusion, which is superior to that of gravitation, it ascends into the upper regions and, mingling with the whole amount of air, is no longer injurious.

To understand this wonderful and beautiful law of diffusion, take two vessels (Fig. 19), and let one be filled with hydrogen gas—the lightest known—and the other with carbonic-acid gas, 22 times heavier; unite the vessels by a tube *t*, placing the jar of heavy gas below, and that containing the light gas above; in a short time the gases will become mixed, the lighter descending and the heavier ascending.

Another most important arrangement is that plants in sunlight absorb large quantities of this carbonic acid, and giving us back the oxygen, they retain the carbon for their

nourishment: so beautifully and so marvellously has the great Creator balanced all the operations of Nature.

As I have spoken of the chemical combination of the gases composing water, and the mechanical mixture of those

Fig. 19.—Experiment showing the Diffusion of Gases.

composing the air, for the sake of those readers who are not acquainted with chemistry, I will further illustrate the difference between such mixtures.

When two or more elements unite chemically, the compound has generally very different properties from its elements taken separately. Salt (NaCl) is a chemical compound of the poisonous gas chlorine and the metal sodium,

which by their combination become not only a very wholesome substance, but also an indispensable necessity both to animals and plants. Again, the elements oxygen, hydrogen, and nitrogen, so necessary to our very life, will produce, when chemically combined in the proportions HNO_3, the corrosive and deadly poison, aquafortis (*Nitric Acid*).

A mechanical mixture, on the other hand, does not change the properties of its elements or compounds; and frequently the components of such mixtures again separate and arrange themselves according to their respective specific gravities. For instance, pour a little salad oil into some water and beat it up with a switch, a creamy substance is the result; but let the mixture stand for a short time, and the oil will separate itself from the water, and will float at the top quite distinct from it. If we now add some potash to the mixture, the oil will not again separate from the water, because a chemical compound will be the result; and the soap which is formed would have detergent or cleansing properties, enabling it to remove the very stains which the mechanical mixture of oil and water dropped upon a piece of linen might have previously made.

Frequently elements thus chemically united occupy very much less space than when they are disunited. In the case of water 12,000 cubic feet of oxygen and hydrogen in a gaseous state would only occupy one cubic foot as liquid water.

The next thing to consider is the weight and height of the gaseous envelope of our globe. Its weight was first discovered in 1640, when the Grand Duke of Tuscany having ordered the construction of some fountains upon the terrace of the palace, it was found impossible to make the water rise more than thirty-two feet. The duke wrote to Galileo in reference to this strange refusal of the water to obey the pumps.

Torricelli, the pupil and friend of Galileo, in 1643 dis-

covered and explained the cause of this phenomenon by the invention of the barometer; which showed that a column of air extending from the Earth to its utmost boundary above the surface balanced thirty-two feet of water, and not quite thirty inches of mercury. This is a pressure of about fifteen pounds weight on every square inch, and therefore a man of moderate size has upon the surface of his body a pressure of from twelve to fourteen tons; but this pressure being equal in all directions, all through his body as well as around it, he does not feel it inconvenient, although he would be very uncomfortable if fourteen tons of coal were piled upon him.

Well, then, it was found that the mercury in the barometer sank in the tube as it was taken up a mountain or in a balloon; hence it was that Gay-Lussac, having taken up in a balloon some flasks from which he had previously exhausted the air, found roughly that the atmosphere at the height of about five miles above the Earth's surface has less than half the density it has at the level of the sea. Humboldt afterwards made a more correct estimate on the top of Chimborazo, 20,014 feet above the sea-level, where he found that the barometer sank to a little more than 14 inches (14·17); and Elie de Beaumont on the top of Mount Etna, about two miles in perpendicular height, found that he had nearly a third in weight of the aërial mass beneath him. This would give only six miles for the height of the atmosphere, if its density were the same throughout, which is not the case, for the *minimum* height has been calculated to be about forty miles, as experiments in reference to twilight seem to prove; but as meteors take fire at the height of seventy miles, it is evident that the air, though in a very rarefied condition, must extend to that height.*

* For further information upon some of the subjects of this chapter I would recommend my readers to obtain Flammarion's popular work on "The Atmosphere," edited by Mr. James Glaisher, F.R.S., and Captain Maury's "Physical Geography of the Sea." They are both excellent works. (Sampson Low and Marston.)

Flammarion, when speaking of the atmosphere, says that life and death are alike in the air, and perpetually succeed the one to the other by the exchange of gaseous particles. Thus the atom of oxygen which escapes from the ancient oak may make its way into the lungs of an infant; and the last sigh of a dying man may go to nourish the brilliant petal of a flower. The breeze which caresses the blades of grass goes on its way, until it becomes a tempest that uproots the forest trees. It is by this unceasing activity of the aërial envelope that it nourishes and sustains the tiny lichen and the colossal Eucalyptus tree. And while it keeps up the vital circulation, it is the laboratory of that splendid world of colours which brightens the surface of our planet with ever-changing harmonies, from the gleaming brightness of the summer's sun down to the shadows which cover as with a veil the forest depths. To it we owe the lovely blue of the azure sky and the glowing and glorious tints of the setting sun.

Thus throughout Nature do we find usefulness and beauty combined; and air and water, which seem especially to have composed the second vision of the holy prophet, proclaim the power and the glory of Him who created them so perfect, and made them so wonderfully and universally useful to His creatures.

"*And the evening and the morning were the second day.*"

CHAPTER IV.

"Let the Dry Land appear."

This third vision of Moses was a very different one from the previous ones, for the rocks, whose formation we before described, were being heaved and tilted up from beneath the ocean and raised above its surface by volcanic forces, so that instead of a calm and placid sea, he might have looked upon scenes of terrific grandeur.

In the last chapter I described to you some of the rocks which we may suppose to have been formed in the earliest stages of the Earth's history, by the wearing away of the first-formed crust when covered by an all but universal sea. The earliest Cambrian rocks of Scotland contain at their base great deposits of boulders and pebbles, the result of the wasting action of the sea along the line of an ancient shore. Dry land may have existed at a still earlier time, but we have distinct evidence of it here.

And now, as we commence the study of the truly stratified rocks, it may be useful to give some idea of the thickness of these beds, and the importance which they have in the present condition of the Earth's crust. Various estimates have been made of the thicknesses of the rocks. One of the most recent is that by Dr. S. Haughton and Prof. E. Hull. The Azoic rocks, containing no remains of living things, are those of which we have been already treating. The Palæozoic rocks are those containing the older forms of life,

and include all up to the base of the Trias. All newer than that are here called Neozoic.

	Maximum thickness.	Per cent.
Neozoic Rocks	41,050 feet	23·2
Palæozoic ,,	75,400 ,,	42·5
Azoic ,,	60,750 ,,	34·3
Total thickness	177,200 ,,	100·0

This thickness, more than 33 miles, is not found in any one place; it is obtained by adding together the greatest known thicknesses of rocks in various districts.

Whilst the Earth was cooling, cracks and fissures would be formed in the crust, into which the waters of the ocean would rush, and, coming into contact with the molten interior, would be instantly turned into steam, the expansive force of which we all so well know.

These operations of Nature are still going on, and enable us to estimate the intensity of those early convulsions. Our earthquakes and volcanic eruptions, the upheavals and subsidences of districts, and other similar phenomena, may all be traced to similar causes; and therefore I will give some account of them, in order that my readers may fully appreciate what was really meant when the edict went forth—"*Let the dry land appear.*"

It is not much more than 120 years ago that a remarkable upheaval took place, which, though on a comparatively small scale, was sufficient to give us some idea of the splendour and grandeur of the scenes which must have taken place when "the mountains were brought forth."

Mungo Ponton relates, in his excellent work on "Earthquakes and Volcanoes,"* that in Mexico there was a highly-cultivated farm belonging to Don Pedro di Jorullo. The plain was watered by two small rivers called Cuitimba and San Pedro, and was bounded by mountains composed of

* T. Nelson and Sons.

II.—Jorullo, in Mexico.

basalt, the only indications of volcanic action. These fields were well irrigated and among the most fertile in the country, producing abundant crops of sugar-cane and indigo.

In the month of June, 1759, the cultivators of the farm began to be disturbed by strange subterranean noises of an alarming kind, accompanied by frequent shocks of earthquake, which continued for nearly a couple of months; but they afterwards entirely ceased, so that the inhabitants of the place were lulled into security. On the night between the 28th and 29th of September, however, the subterranean noises were renewed with greater loudness than before, and the ground shook awfully. The Indian servants living on the place started from their beds in terror, and fled to the neighbouring mountains. Thence gazing upon their master's farm, they beheld it, along with a tract of ground measuring between three and four square miles, raised up, as if it had been inflated from beneath like a bladder. At the edges this tract was uplifted about thirty-nine feet above the original surface, but so great was its convexity that towards the middle it attained a height of no less than 524 feet (Plate II.).

The Indians who beheld this strange phenomenon declared that they saw flames issuing from several parts of this elevated tract, and that the entire surface became agitated like a stormy sea. Great clouds of ashes, illuminated by volcanic fires glowing beneath them, rose at several points, and white-hot stones were thrown to an immense height. Vast chasms at the same time opened in the ground, and into these the two small rivers above mentioned plunged. Their waters, instead of extinguishing the subterranean conflagration, appeared only to add to its intensity.

Quantities of mud enveloping balls of basalt were now thrown up, and the surface of the elevated ground became studded with small cones, from which volumes of dense vapour, chiefly steam, were emitted, some of the jets rising

from twenty to thirty feet in height. These cones the Indians called *ovens*, and in many of them is heard even now a subterranean noise resembling that of water briskly boiling.

Out of a great chasm in the midst of these ovens there were thrown up six larger elevations, the highest being 1,600 feet above the level of the plain, and now constituting the principal volcano of Jorullo, which has a regular volcanic crater, whence have been thrown up great quantities of stones and lava containing fragments of older rocks. The ashes emitted from the volcano were thrown to an immense distance, some of them having fallen on the houses at Queretaro, 150 miles from Jorullo.

The volcano continued in this energetic state of activity for about four months; in the following years its eruptions became less frequent, but it still continues to emit volumes of vapour. The two rivers which disappeared on the first night of the great eruption now pursue an underground course for about a mile and a quarter, and reappear as hot springs with a temperature of 126° Fahr.

This wonderful volcanic upheaval is all the more remarkable from the inland situation of the plain on which it occurred, it being no less than 120 miles distant from the nearest ocean; while there is no other volcano nearer to it than 80 miles.

How privileged were the men who saw one of these upheavals of the Earth's crust! And though but a small matter compared with the rising of mountain-chains, yet it must have been strikingly grand to see a mountain springing up from the level ground, with all the attendant phenomena; and if they were believers in Revelation, how it must have convinced them of the truthfulness of the Biblical story, and the great power of the Creator in ordaining laws which should bring about similar results to those related by Moses!

There are some differences of opinion as to the way in which the tall Andes were first heaved up; but if it took place as suddenly as the upheaval of Jorullo, the scene must have been of the grandest description. The foaming ocean would dash its enormous billows mountains high, whilst the noise of the splitting and the crashing of the rocks would be louder than that of ten thousand cannon. Molten lava would also issue from the crevices and the craters, lighting up the chaotic confusion with a lurid glare, and falling back into the sea would decompose its waters, producing explosions too terrific for the mind to conceive; and then all the artillery of the electrical batteries of Nature would be adding their rolling thunders and flashing lightnings to these mighty convulsions.

We can imagine, too, how the roaring waters would rush together to form the Pacific. Here, again, we find the Psalmist describing most graphically such a scene:—"*The waters stood above the mountains. At Thy rebuke they fled; at the voice of Thy thunder they hasted away. They go up by the mountains; they go down by the valleys unto the place which Thou hast founded for them.*" (Ps. civ. 6, 7, 8.)

Many have wondered how it was that volcanoes several miles high should be able to belch out streams of lava, which must have come from the heated interior miles below the surface. I have just now mentioned that water has much to do with such convulsions.

Let us then try to imagine the influx of the sea into one of the fissures formed in the crust. On coming into contact with the molten matter it would instantly be changed into gaseous steam, expanding to more than 1,800 times its original bulk; this would press with enormous force, not only upwards upon the crust of the Earth, but also downwards upon the surface of the melted lava. If there were no vent for the lava to escape, an earthquake would be the result, or a fissure would be opened for lava to come up, and

a volcano would be formed by the matter erupted through this vent.

Should there, however, be a volcanic chimney near to where the inpour of water took place, then would the lava rise from those immense depths and stream down from the mountain-top, carrying destruction in its course. The

Fig. 20.—Section of Volcano in action.

annexed cut (Fig. 20) gives an ideal representation of a volcano in action, with the molten matter below the crust being forced up the shaft, or neck, which acts as a safety-valve.

The volcanoes on the surface of the globe known to be in an occasional state of activity number about three hundred: and these may be divided into two classes—the

isolated or *central*, and the *linear*, or those volcanoes which belong to a *series*.

The first are active volcanoes around which there may be established many secondary active mouths of eruption, always in connection with some principal crater. The second are disposed like the chimneys of a furnace, along fissures extending over considerable distances. Twenty, thirty, and even a greater number of volcanic cones may rise above one such rent in the Earth's crust, the direction of which will be indicated by their linear course.

Etna, Vesuvius, and Teneriffe are instances of central volcanoes. The long rampart-like chain of the Andes, from the south of Chili to the north-west coast of America, presents one of the grandest instances of a continental volcanic chain.

Darwin relates that on the night of the 19th of March, 1835, the attention of a sentry was attracted to something like a large star, which gradually increased in size till about three o'clock, when it presented a very magnificent spectacle. By the aid of a glass dark objects in constant succession were seen, in the midst of a great glare of red light, to be thrown up and fall down. The light was sufficient to cast on the waters a long bright reflection. It was the volcano of Osorno in action. And now comes the most interesting part of his narration, proving that the Andes are a grand volcanic chain. On that same night in Chili, 480 miles farther north, the mountain Aconcagua was in action; and more remarkable still, there was, only six hours afterwards, a great eruption of Coseguina, 2,700 miles still farther north. The ashes discharged were hurled out of the crater with such force that they were carried to a distance of 700 miles, and the roaring noise of the eruption was heard at San Salvador, 1,000 miles distant from the conflagration. Notwithstanding that these various mountains were giving vent to the pent-up gases, the outlets were

not sufficient, and an earthquake was the result, which was felt 1,000 miles away. It was remarkable also that Coseguina had been twenty-six years dormant.

The account of these eruptions is the more interesting, as it shows that though ages upon ages—yea! æons upon æons—must have passed since the upheaval of the Andes, yet we find the same processes at work, and similar convulsions taking place now, though of course in a very modified form.

One of these enormous chimneys is Cotopaxi, the highest volcano in the world; it is 19,000 feet above the level of the sea, or three-and-a-half miles in perpendicular height. It is covered at its summit with perpetual snow, and so regular is the form of its cone that it has the appearance of having been turned in a lathe. Eruptions of this mountain are rare, but there are columns of vapour continually rising from the crater on the summit. The last great eruption of this volcano was in 1741, when the column of ashes and vapour from the crater is said to have risen a mile above the cone.

The figures that would be necessary to express the force required to send up the lava from the bowels of the Earth to the top of this mountain and a mile above it would be so great that I should confuse my readers if I even attempted to put them down; but I think they will understand something of it when I say that a huge mass weighing 200 tons was in 1533 projected from the crater to a distance of ten miles—that is, a rock weighing 448,000 pounds was hurled 52,800 feet.

Of course my object in this chapter is not to give an account of all the wonderful volcanoes in the world, but to select a few which will illustrate the special subject I am treating of, and show the forces that are still in operation and caused the first upheaval of the rocks to form dry land. I will therefore confine myself to a few remarkable ones, viz., Etna, Vesuvius, and those in Hawaii.

ETNA

rises in solitary grandeur on the eastern coast of Sicily; its height above the level of the sea is a little over 10,870 feet, considerably above the line of perpetual snow; it accordingly presents the striking phenomenon of volcanic vapours ascending from a snow-clad summit. The base of the mountain is eighty-seven miles in circumference and nearly circular. A very remarkable and interesting feature of it is that from the base to the summit you pass through many of the climates of the world, and you also behold all the different varieties of vegetation of the torrid, temperate, and frigid zones.

The lower portions are exceedingly fertile and richly adorned with corn-fields, vineyards, olive-groves, and orchards. Above this region are extensive forests, chiefly of oak, chestnut, and pine, with here and there clumps of cork-trees and beech. Amongst the chestnut-trees there was a very remarkable one called the "tree of a hundred horsemen," because its spreading branches and luxuriant foliage were said to extend so far that a hundred horsemen could stand under its shade. In this forest region are grassy glades which afford rich pasture to numerous flocks. Then comes a volcanic desert covered with black lava and slag. And last of all we come to the snow-clad top with its arctic temperature.

The earliest record of the eruptions of Etna is found in Thucydides, who states that three had occurred before the beginning of the Peloponnesian war, which was in 431 B.C. I will not, however, particularise them, or relate the striking incidents in connection with them, but will only notice an eruption which happened in the year 1669. The old crater had become filled up and solidified to such an extent that there was not an opening sufficient for the lava to force itself through, and consequently, the underground gases and vapours being pent up, an earthquake was the first result.

The people of the town of Nicolosi, situated on the sides of the mountain, some twenty miles from the top, were alarmed at the rumbling noises they heard, and many of them fled to the plains below.

Soon after, the whole of the ground was agitated, and then some of the buildings began to totter, and shortly afterwards all of them came down with a fearful crash, and the town from end to end was a mass of ruins. Then an explosion took place with a thundering noise, which was heard at a distance of forty miles, and a fissure opened in the sides of the mountain, from which there issued an immense stream of flowing lava. This downpour of lava is well described by a poet in these words :—

> " The fluid lake that works below,
> Bitumen, sulphur, salt, and iron scum,
> Heaves up its boiling tide. The lab'ring mount
> Is torn with agonising throes. At once
> Forth from its parted side there blazing pours
> A mighty river, burning in proud waves
> That glimmer through the night to yonder plain
> Divided there a hundred torrent streams,
> Each ploughing up its bed, roll dreadful on
> Relentless. Villages and woods and rocks
> Fall flat before their sweep. The region round,
> Where myrtle walks and groves of golden fruit
> Rose fair—where harvest waved in all its pride,
> And where the vineyard spread its purple store
> Maturing into nectar—now despoiled
> Of herb, leaf, fruit, and flower from end to end,
> Lies buried under fire and glowing sea."

Near its source the velocity was 1,500 feet an hour; but this rate was soon much diminished, for the surface getting encrusted the under-current proceeded more slowly, and therefore it took twenty days to accomplish the first thirteen miles of its journey, and twenty-three days were required for its passage over the last twelve miles. Five other fissures parallel to this then gaped open, and from them all were belched

forth steam, ashes, and lava; the latter poured down the burning mountain in a stream of liquid fire, and very soon reached one of the towns on the mountain-side, which it set on fire and overwhelmed with molten lava. Onward it flowed with resistless force, and then soon came to another town, and then to a village, and then again to a town. And thus town after town and village after village fell, till no less than fourteen were utterly destroyed.

It would be impossible to relate the horrors of those days and nights, when the inhabitants saw the fiery river flowing on, and knew that it must reach their homesteads, and leave nothing behind it but ashes. Every one knew that it would flow on slowly but surely until it reached the sea, and that therefore all towns in its course must be overwhelmed by this dreadful stream, which was thirteen miles in length and six in breadth.

Catania, some ten miles from the hideous rent, was in a direct line with the stream, and the people tried to divert it by breaking through the sides of the crust. The inhabitants, however, of Paterno, seeing that such a diversion would turn the stream upon their village, forcibly compelled the people of Catania to desist; the latter were obliged to await its gradual advance, and trust to the solidity of their walls, some sixty feet in height, to preserve them.

The agony of the Catanians as the liquid fire approached their town cannot be conceived; still they hoped against hope that they might be saved, either by its skirting the town or by the mountain discontinuing to pour forth its molten current. At last it reached their walls, which, without levelling, it ascended and overran, pouring down into the town on the other side a cascade of fire.

Then were the inhabitants indeed filled with alarm: women screamed, children cried, and men turned pale. But on went the fiery and relentless flood, burning and over-

whelming street after street, until it reached the opposite wall, over which it flowed and proceeded to the sea. Then commenced a combat between the fire and water, of which it is impossible for us to form an idea, and even those who witnessed the terrible scene were wholly unable to describe its awful grandeur.

Zurcher* says that the lava, cooled at its base by contact with the water, presented a perpendicular front fourteen or fifteen yards broad, and advanced slowly, carrying like a glacier enormous solid blocks red with heat. When they reached the extremity of this movable causeway the blocks fell into the sea, filled it by little and little, and the fluid mass advanced by so much.

At this contact large bodies of water reduced to a state of vapour rose up with frightful hissings, and fell in a salt rain over the neighbouring country. In a few days the lava had carried forward the line of the beach some 330 yards.

During the seven eruptions between 1754 and 1812, from the enormous rents and orifices that opened, immense quantities of lava and scoriæ poured forth; and sometimes in a few days cones were formed round these orifices measuring in height 1,000 feet; this especially happened in 1771, when the lava flowed down the mountain's sides in cascades of glowing fire (Plate III.). We see then clearly that the mass of Etna must have been wonderfully increased by this enormous quantity of material ejected during *historic* times; and in comparing this period with the primitive one—the immense length of which is shown by geology—we are led to believe that the greater part of the mountain has been formed by a series of eruptions, belching forth rocks, scoriæ, and lava.

Solomon, in the 8th chapter of Proverbs, shows his intimate knowledge of these processes of Nature; for when he

* MM. Zurcher and Margollé, "Volcanoes and Earthquakes." (Blackie.)

III.—Eruption of Etna, 1771: The Cascade of Fire.

is speaking of the personal character of the Messiah, he says (verses 23—26) :—

"I was set up from everlasting, from the beginning, or ever the Earth was.

"When there were no depths, I was brought forth; when there were no fountains abounding with water.

"Before the mountains were settled, before the hills was I brought forth:

"While as yet He had not made the earth, nor the fields, nor the highest part of the dust of the world."

Is there not here, first, a statement of the non-existence of the Earth before ever the nebulous and meteoric bodies had received the Creator's fiat to form its solid mass?

Then, next, is not the ocean alluded to as a condition following the first formation of the globe?

And, thirdly, does not Solomon put in its proper place the upheaval of the rocks, producing mountains and hills; and still further, in its right order, the outburst of vegetable life?

How will the sceptic get over this remarkable harmony of sequence between Nature and Revelation?

For it is not Moses alone who has given us the correct scientific account of the order of creation, but David and Solomon also confirm his statements. The wisdom of both doubtless amounted to inspiration; and whilst specially endowed with talents that fitted them to be great kings, they were equally gifted with the ability to understand the wonders and the mysteries of Nature.

VESUVIUS.

Besides molten lava, volcanoes frequently throw out ashes, scoriæ, and masses of rock, and thus add very much to their own size and height. This happened with Vesuvius, which in A.D. 79 is said to have thrown out more matter than the solid

contents of the whole previous mountain. Anterior to this period the country around was the most lovely that could be imagined; from the heights of the mountain down to the city of Naples, gardens and villas so abounded that it seemed like one vast and beautiful city. The fertility of the ground being remarkable, as it generally is in all volcanic districts, the vine, the orange, the citron, and all other delicious fruits, grew luxuriantly. The cause of this fertility most probably is that the pulverised lava contains so many of the salts necessary for the nutriment of fruit-trees. Pompeii and Herculaneum were situated at the foot of the mountain, and seem to have been the resort of wealthy Romans. Alas for them! they had to pay dearly for all their rural and luxurious enjoyments.

On the 24th of August, 79 A.D., about one in the afternoon, an immense cloud was seen by Pliny to issue from the mountain, not unlike in shape to a pine-tree, which shot up to a great height, in the form of a trunk, and extended itself at the top into branches. It appeared sometimes bright and sometimes dark and spotted, as it was more or less impregnated with cinders. It soon spread over the sky, so as to completely hide the sun; the inhabitants of all the district were filled with much alarm, which was heightened by convulsive motions of the earth causing the houses to totter, the sea to roll back upon itself, and many marine animals were left upon the shore. In the utmost consternation the people fled from their houses, fearing that the edifices would fall upon them, but only to encounter outside another danger equally awful—viz., that of being buried alive under the showers of ashes that were now pouring down. Some fled to the open fields with pillows tied upon their heads—their only defence against the pitiless downfall of stones and scoriæ.

Though midday, the darkness was terrible. It was not

IV.—Destruction of Pompeii (according to the description of Pliny the Younger).

like that of a cloudy night, or when there is no moon, but of a room when it is shut up and all the lights extinguished.

Nothing then was to be heard but the shrieks of women, the screams of children, and the cries of men; some calling for their children, others for their parents, others for their husbands, and only distinguishing each other by their voices; one lamenting his own fate, another that of his family; some wishing to die from the very fear of dying; and the greater part imagining that the last eternal night was come which was to destroy all mankind and the world together. Now flashes of forked lightning illumined the awful scene with a lurid glare, then again flames would burst from the mountain, accompanied by terrific thunder, adding yet fresh terrors to the fleeing multitude. (Plate IV.)

When the eruption ceased, Pompeii was buried under a covering of stones and ashes from twenty to twenty-four feet deep. Five-sixths of the material of this covering consisted of pumice-stones of an irregular shape, from the size of a pea to several inches in diameter. Over this there was another layer of an average depth of two feet, which appears to have been attended in its descent with an enormous fall of water. The outer surface has since been converted into a fine mould, and corn and fruit-trees, particularly the mulberry, grow readily upon it.

The general belief is that most of the people escaped; for, though they were assembled in the Amphitheatre at the time of the shower, very few bodies have been found there; probably the skeletons within the building were those of gladiators already slain. Still, some two thousand are supposed to have perished in the dire catastrophe, and amongst them Drusilla, the wife of Felix, with her son Agrippa.

Some of the ashes erupted were so fine and so mixed

with water, that many people were encased with the wet powder; and the entire impressions of their bodies have been thus preserved with great accuracy. Some of them are of women young and beautiful; and the very pattern of the lace they wore is still visible. Others are of men in the last agonies of death, whilst some seem to have died in their sleep.

Fig. 21.—Existing Crater of Vesuvius.

What wondrous stories many of these bodies tell of what took place on that dreadful day!

In one villa of a patrician of high rank, the ladies and servants and children of the family seem to have huddled themselves together in the cellars, where they were smothered; whilst the master of the house, evidently intent on selfishly saving himself, and regardless of his family, was found outside the garden-gate, through which he was fleeing with as

much money and other valuables as his slave—who lies beside him—could carry. Eighteen hundred years have rolled by, and this ignoble act has come to light to teach us that our sins must eventually find us out, even after the lapse of thousands of years.

How different was the position of the brave sentinel, who was found standing erect, lance in hand, at the gates of the town! I love to think of this man, who, whilst he saw thousands rushing away from the city to get to a place of safety, staunchly stood at his post of duty; and though the hot ashes were gradually burying him alive, still remained and faced a dreadful death rather than sully his name by an ignominious flight. Let us honour the memory of this brave soldier, who has set us all so noble an example of unflinching integrity. So shall good deeds shine forth as the day, even though they may be buried from sight whilst generations upon generations have lived and passed away!

Vesuvius is often still in an active condition, and as late as 1872 there was a very violent eruption; rivers of lava poured down all its sides, and stones were ejected from the crater to the height of half a mile. The condition of the crater is still frequently seen as in Fig. 21.

There are other volcanoes which are very remarkable, and which differ in so many particulars from those I have described, that I must give you an account of them.

The Volcanoes of Hawaii.

In the group of the Sandwich Islands there is one called Hawaii, which contains four large volcanoes; two of them are of immense size, Mauna Kea being 18,000 feet, and Mauna Loa 16,000 feet above the level of the sea. Although their height is thus great, the ascent to their summits is so gradual that their circumference at the base is enormous; each of them is reckoned to be more than twice the bulk of Etna.

I have told you how Cotopaxi hurls out huge rocks to immense distances; how Etna pours down from its gaping sides large rivers of molten lava; how Vesuvius throws up to great heights cinders, ashes, and scoriæ, which descending bury the whole country round; now I will tell you of jets of lava spirted into the air some 500 and even 1,000 feet above the crater of Mauna Loa, in Hawaii, which falling down with a great noise, flow on for fifty or sixty miles, destroying all before them.

In 1865 the fiery fountain is said to have continued to play for twenty days and nights, varying only as to the height to which the jet rose; sometimes it would be only 100 feet, and then, by some sudden internal impulse, it would rise to 1,000 feet. Try to imagine that you are witnessing this magnificent spectacle of a fountain of fire ascending to the sky, and illuminating all the country round for 200 miles with a light almost equal to that of the sun. And whilst you are gazing upon this splendid scene, you are startled, yea, filled with terror, by an explosion so loud that the very sky seems rent asunder; presently a cataract of fire rushes down the sides of the mountain, and flowing on carries devastation in its course, burning its way through forests, and filling the air with smoke and flames from the ignited timber.

Added to this, a volume of volcanic dust and stones is being thrown up into the air some two miles above the mountain-top, which, falling down, heaps up a cone of solid matter 300 feet in height and a mile in circumference.

The *Sunday at Home* for March, 1882, graphically describes an eruption of this kind which took place as lately as 1881.

These eruptions of Mauna Loa are interesting, as they show that the underground forces from the pent-up steam and gases must exceed those of any other volcano. Not all the

horse and steam power in the world combined would represent the force necessary to produce such a fiery fountain, or to throw up solid matter to such a height.

But this is not all; there is something more interesting still in this mountain. Some 4,000 feet above the level of the sea there is a vast crater called Kilauea, which forms a lake of molten or liquid lava.

The longer diameter of the crater is three miles, and the shorter diameter a mile and a-half; at the bottom of the basin, about 1,000 feet in depth, is a steaming, boiling, heaving lake of fire two miles in length, and nearly a mile in width. Milner gives a description of a visit to it by Captain Lord Byron and a party of officers of the *Blonde* frigate, accompanied by Rev. S. Stewart. On arriving at the brink of the crater, they looked down into the fearful gulf, which was so steep that it seemed as if by a single leap they could plunge into its lowest abyss. Its surface had all the agitation of an ocean; billow after billow tossed its monstrous bosom into the air, and occasionally the waves from opposite directions met with such violence as to dash the fiery spray in the concussion forty or fifty feet high. Such was the agonising struggle of the conflicting elements, with appalling sounds of muttering, sighing, moaning and howling, that one of the party shrank back, exclaiming, "Call it weakness, or whatever you please, but I cannot look again!"

About fifty cones of various heights, active chimneys of volcanic fire, were counted in the abyss, sending forth volumes of smoke and steam; and as evening closed fire after fire appeared glimmering through the vapour. Some of the cones were ejecting fragments of rock, others ashes, lava, and boiling water. Streams of fire seemed to be running among the labouring craters, forming a scene which, in connection with the roar of the elements, was truly unearthly, yet extremely sublime.

It appears that the connection between this crater and the internal fires of the Earth is quite distinct from that of the top of the mountain; and, therefore, in all probability there were once two mountains, and the space between them has got filled up by the volcanic matter thrown out from the several craters.

It would be impossible to represent upon paper the awful grandeur of this lake of fire, but Plate V. will give you some idea of its shape and the surrounding landscape.

The lava in the lake rises and falls several hundred feet, according to the active or quiescent state of the volcano. But instead of overflowing the rim of the crater, as commonly happens in other vents, the column of melted rock, when its pressure becomes excessive, forces a passage through some subterranean galleries or rents leading towards the summit. Mr. Coan, an American missionary, has described an eruption which took place in June, 1840, when the lava which had risen high in the great chasm began to escape from it.

Its direction was first recognised by the emission of a vivid light from the bottom of an ancient wooded crater called Arare, 400 feet deep and six miles eastward of Kilauea. The connection of this light with the discharge or tapping of the great reservoir was proved by a change in the level of the lava in Kilauea, which sank gradually for three weeks, or until the eruption ceased, when the lake stood 400 feet lower than at the commencement of the outbreak. The passage, therefore, of the fluid matter from Kilauea to Arare was underground, and it is supposed by Mr. Coan to have been at the first outflow 1,000 feet below the surface.

The next indication of the subterranean progress of the same lava was observed a mile or two from Arare, where the fiery flood broke out and spread itself superficially over fifty acres of land, and then again found its way underground for several miles further towards the sea, to reappear at the

bottom of a second ancient wooded crater which it partly filled up.

The course of the fiery fluid then became again invisible for several miles, until it broke out for the last time at a point ascertained by Captain Wilkes to be 1,244 feet above the sea-level and twenty-seven miles distant from Kilauea. Thence it poured along for twelve miles in the open air, then leaped over a cliff fifty feet high, and for three weeks ran into the sea. Its termination was at a place about forty miles distant from Kilauea.

The crust of the Earth overlying the subterranean course of the lava was often traversed by innumerable fissures, which emitted steam; and in some places the overlying rocks were lifted up twenty or thirty feet.

This remarkable mountain, therefore, affords examples of the overflowing of lava from the summit of a cone two-and-a-half miles high, and of the underflowing of melted matter.

I must now notice another phenomenon of volcanic regions.

Boiling Springs.

In the island of St. Michael, one of the Azores, there is a round, deep, and lovely valley, its sides covered with myrtles, laurels, and mountain grapes, with wheat, Indian corn, and poplars waving upon its fields, in which many boiling fountains occur. The principal spring, called Caldeira, is on a gentle eminence by the side of a river, and boils with great fury; and the river itself exhibits ebullition in various places, where the water is too hot to be borne by the hand.

But the most remarkable of such springs are found in Iceland, and constitute—owing to their diversified appearances—sublime, beautiful, and terrible objects in that strange region, where the extremes of heat and cold, in the form of ice and fire, are in near proximity.

They are found in various parts of the island, but the chief are situated in its south-western division, on a plain at the base of a low range of hills, about thirty-six miles from Hecla. Here, within a circle of two miles, are above a hundred springs; some of which boil incessantly without any discharge of their contents, whilst others cast their waters high into the air.

To the principal of these springs the name of Geyser is applied, a term derived from the Icelandic *Geysa*, signifying "to burst forth with vehemence and impetuosity."

There are two more remarkable than the rest, and called the Great Geyser and the New Geyser. They are intermittent hot springs, and on approaching the larger of the two it presents the appearance of a circular mound formed by the depositions of the fountain. Ascending the mound, we find a spacious basin partly filled with hot water, clear as crystal, and gently bubbling. In the centre there is a cylindrical pipe or funnel about eighty feet in depth, and from eight to ten feet in diameter, widening at the top, and opening gradually into the basin. The inside exhibits a whitish surface, from the incrustation of silica, which has been rendered smooth by the action of boiling water.

The basin is 150 feet round, and when full the water it contains is about four feet deep, measuring from the surface to the commencement of the pipe. The water occasionally running over the edges of the mound has acted upon the surrounding peat, mosses and grass, encrusting them with stone and furnishing fine specimens of petrifaction.

Such is the Geyser asleep! The whole scene changes when it is in action, which occurs at irregular intervals. Explosions in the bowels of the Earth, like reports of cannon, shake the ground and warn the visitor to retire to a distance, for they announce an eruption. The water in the basin becomes more and more agitated; it boils furiously, and at last

VI.—Great Geyser of Iceland.

is suddenly projected into the air in a succession of jets which are at first inconsiderable, but become more powerful, till a magnificent column is sent up to a great height, finishing the display as though the Geyser, like a thing of life, summoned all her power to dignify her retreat.

This is the grandest part of the exhibition. The atmosphere is filled with immense volumes of steam which, rolling over each other as they ascend through white columns of water, shivering into foam and spray, are seen spreading in all

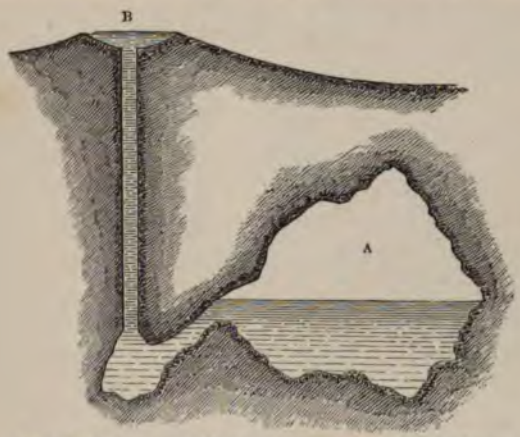


Fig. 22.—Supposed Cause of Intermittent Eruptions.

directions. As the jets rise out of the basin the water reflects the most beautiful colours, sometimes a pure and brilliant blue, or a bright sea-green; but in its further ascent all distinctness of colour is lost, and the tops of the jets, receiving the rays of the sun, are as white as snow. It appears from many observations that the height of the jets is very irregular, and the power of the Geysers very unequal.

Plate VI. represents the Geyser in action. Sir George Mackenzie, in his now classical work "Travels in Iceland," proposes the following explanation of these intermittent eruptions (Fig. 22). He supposes that there are underground

caverns partially filled with water which percolates through the soil above, and this water is boiled by being in contact with heated rocks, while the steam accumulating in the space above it (A) gains an elastic force sufficient to blow the water out of the tube (B).*

M. Zurcher gives the following account of another boiling spring, about fifty paces from the Great Geyser, and called the Strokr (Fig. 23); it is constantly making a loud bubbling

Fig. 23.—The Strokr and other Boiling Springs.

noise, which has procured for it the epithet of "The Devil's Kettle," and, like its neighbour, it sends up intermittent jets of water to a great height. Its eruptions can generally be induced by throwing into the opening clods of earth or grass. Then, without any perceptible moving of the earth, and after having completely suspended the tremendous noise that it makes, the spring is seen slowly rising from its well, and

* Professor Tyndall, in his lectures upon heat, gives another ingenious explanation of this intermittent action.

scarcely has reached the edge when, like a furious animal which has been forced to leave its retreat, it darts into the air a magnificent column, and scalds the face of the individual who has been imprudent enough to provoke the display.

Earthquakes.

I noticed some time since that, notwithstanding the destruction caused by volcanoes, they must be considered as safety-valves, allowing the escape of steam and gases, that would otherwise do much more damage if pent up, by causing earthquakes, which not only change the position of the strata, but also cause upheavals and depressions of the Earth's crust.

The causes of earthquakes are more various than those which produce eruptions; these I will therefore first mention, and then will give a few instances of great earthquakes by way of illustration.

Perhaps you will be surprised when I tell you that the simple flowing on of a river—yea, even of a small stream—might help to bring on eventually an earthquake. And yet it is so; for as a river rolls on in its course, it wears away the rocks, and carries these disintegrated minerals down to the sea, along with many other substances, both animal and vegetable, acquired from the land on both sides of its banks. Thus it forms deltas, and carries into the ocean an enormous amount of materials, which accumulate upon its bed, and in the course of time press heavily upon the under-strata and so upon the molten lava, causing a re-adjustment of its position, ending perhaps in an earthquake or an eruption.

This downward pressure in one place would also cause an upheaval in another; for in some parts where the crust of the Earth was thinner, it might be forced up by the upward pressure of the molten masses.

Whenever the strata become dislocated, from the causes above assigned, or any other, it is probable that there may

be formed deep clefts, through which the waters of the ocean, of great lakes or rivers, percolate, until they come into contact with highly-heated matter underneath.

The waters, on descending to a comparatively moderate depth, would be raised above the boiling-point; so that if on their passage downwards they should encounter any deeply-seated underground cavity, they would instantly burst into steam with an explosion of terrific force; and in proportion to the quantity of water, so would the superincumbent strata be more or less upheaved or violently shaken.

I have before mentioned that water, if subject to great pressure, will retain its liquid form when raised to a considerable temperature, in which condition its solvent power on minerals—especially those composing volcanic rocks—is greatly augmented. In like manner, the gases which issue from volcanic vents may be reduced to the liquid condition under the strong pressure exerted by the superincumbent strata at great depths, and may retain their liquidity even when raised to an intense heat.

The most common substances ejected from the craters of volcanoes are carbonic acid, oxygen, hydrogen, nitrogen, water as steam, sulphurous acid, and sulphuretted and carburetted hydrogen. These coming into contact with the air, group themselves anew and enter into other combinations. Water and sulphuric acid are formed, and a quantity of sulphur is set free, which deposits itself as native sulphur in cavities of the rocks. The sulphuric acid combines with lime, iron, and other substances contained in the lavas and surrounding rocks. The water escapes into the atmosphere.

Any sudden diminution of the pressure over particular spots would cause the intensely hot water and liquefied gases to assume the aëriform state with sudden and explosive violence, so producing an enormous underground disturbance.

It will be remembered that in a former chapter I spoke of

some metals which take fire on coming into contact with water, as potassium and sodium. Now these being the bases of two of the alkalies, which form so large a portion of the composition of the globe, may exist in large quantities, in a free state, in the Earth's interior. Water or steam gaining access to these substances would be decomposed, and much gas and heat would be evolved.

That sulphur performs an important part in promoting volcanic activity is evidenced by the abundance of that combustible in the products of volcanoes. Titanium also, whose presence has been detected in the erupted matter of some volcanoes, may be set on fire by contact with nitrogen gas at a high temperature; and the same property is exhibited by boron, whose presence in the form of boracic acid is also characteristic of some volcanic ejections.

Though I have spoken of these various things as being the probable causes of earthquakes, I would also say that there is abundant evidence to prove that such suppositions are based on true philosophical reasoning; for as I proceed I shall show that the beds of the seas have been many times filled up, not only by the matter brought down from the rivers, but by the deposit of dead marine animals, some idea of the amount of which may be formed by looking at Shakespeare's Cliff, composed of accumulations ages ago, when it was below the waters of the ocean. That fissures and crevasses suddenly gape open, through which water could penetrate to the depths below, we are perfectly sure; for frequently have such chasms opened on the land, and therefore they might equally do so under the ocean. In Calabria, in the year 1783, fissures opened 500 feet broad, and 1,000 feet long, and down them were precipitated men, women, and children, houses, churches, public buildings, and whole farms. Some of these frightful ruts closed up again, whilst others remained open. Perhaps my little sketch (Fig. 24) may help

you to understand this. The arrows below show the upheaval of the lava, causing the crust to open in fissures, which, on the sinking of the lava, would again close, and bury up whatever might have fallen into them. Fig. 25 shows some permanent openings of this kind near Jerocarne, in Calabria; they run in all directions, giving the ground the appearance of a "starred" pane of glass.

During the earthquake of Riobamba, in 1794, the chasms

Fig. 24.—Showing the Openings caused by an Upheaval of the Earth's Crust.

opened and closed so suddenly that some men, only buried up to their shoulders, were saved by stretching out their arms. Portions of long trains of laden mules were engulfed, whilst the other portions escaped.

Perhaps the most extraordinary thing was the sinking down of massive houses without injury or dislocation, so that the inhabitants sank with them, also uninjured, and could light candles, and pass from room to room, debating with each other their chances of escape, and living upon the provisions that were in the houses at the time of their

sinking; and after two days they were extricated safe and sound. With the bulk of the inhabitants, however, it fared far otherwise. The loss of life in the city and throughout the district convulsed was enormous; 40,000 persons altogether perished.

Of the earthquake of Lisbon we have several most graphic accounts, one of which, by Mr. Wolfall, a surgeon, was given in a letter addressed by him to one of the Fellows

Fig. 25.—Fissures near Jerocarne, in Calabria.

of the Royal Society of London, dated Nov. 18th, 1755, and to be found in the *Philosophical Transactions*. From that, and several other accounts, especially that by Mr. Mungo Ponton, I will endeavour to describe this awful catastrophe; and sad as the picture is which I am about to draw, it does not approach the reality.

On the night of the 31st of October, 1755, the citizens of this then beautiful city lie down to sleep, perfectly unconscious of what is awaiting them on the morrow. The morning of the 1st of November dawns upon them, and

gives no sign of the approaching calamity. The sun arises in its brightness, the warmth is genial, the breezes gentle, the sky serene. It is All Saints' Day, a high festival in the Church of Rome; and all the people, dressed in their best attire, are flocking to the cathedral, and various churches, to enjoy the gorgeous ceremonials especially enacted upon this day.

These sacred buildings are crowded in all parts, and the people are now joining in the devotions, now watching with intense interest the imposing processions of priests and bishops, and again ravishing their ears with the solemn music; when suddenly some horrible sounds drown the peal of the organs and the voices of the choirs.

Underground thunders are heard, filling the panic-stricken multitudes with paralysing terror; forthwith the ground begins to heave with a long and gentle swell, producing giddiness and faintness among the people. Looking up, they see the tall piles sway to and fro like willows in the wind. One loud, long shriek of horror rises from the terrified masses. Many rush to escape from the buildings, but they are met and stopped by other crowds rushing from the streets to escape the dangers there.

Again the earth heaves, and this time with a longer wave. Crash! Down come the ponderous arches, the stately columns, the massive walls—the lofty spires tumbling upon priests and people.

In a moment all are buried in one indistinguishable mass of horrible ruins, and only those who are nigh the doors escape to tell the tale. Alas! alas! how sad a thing for such a multitude to be thus hurried in one moment into eternity! And yet what place could be better to face death in than a temple dedicated to the worship of God? And those offering up their devout prayers, and sincerely singing His praises, assuredly found themselves suddenly

VII.—The Earthquake of Lisbon.

transferred from earth to heaven to finish their songs in the choirs of angels.

The terrible earth-wave crosses the city, and a large number of private houses come tumbling down upon their inhabitants—mother and child, father and son, the hoary-headed sire and the infant in the cradle, are in one moment crushed with stones, bricks, and timbers. The air is filled with groans of agony, screams of despair. The foot-passengers are knocked down, bruised, wounded, and killed; some also are choked with the suffocating dust which even shuts out the sun. This dust soon falls to the ground, and then it is seen that a considerable number of houses are still standing. Hope springs up in the survivors' hearts; they trust that the worst is past, and that the uninjured part of the city will remain. But, alas! these hopes are not to be realised. Another earth-wave traverses the devoted city, and down come the remaining mansions, the royal residence, the churches, the convents, the public granaries, the warehouses—yea, all the buildings—and Lisbon is reduced to chaos. (Plate VII.)

The citizens rush from the scene of devastation to the sea-shore, but here a new calamity overtakes them. The tide, after first retreating for a little, comes rolling in with an immense wave fifty feet in height, carrying with it ships, barges, and boats, and dashing them in dire confusion on the shore; destroying and drowning the brave sailors and the terror-stricken passengers, the naval officers, and the lowly fishermen. Numbers of the people on the bank are swept away into the seething waters, and are drowned.

Some little distance off there is a fine new marble quay, erected at a great expense, and standing high above the dashing foam, with foundations as solid as the rock itself. They crowd upon this place of refuge, and see the great sea-wave sweep harmlessly by them; but whilst they are congratulating

themselves upon their safety, an awful chasm opens beneath them, and the vast structure, with the whole of its living burden, is utterly engulfed. Not a single corpse, not a shred of raiment, not a plank or a splinter floats to the surface; they all are gone down into the bowels of the earth, and a hundred fathoms of water cover the spot.

About two hours after the overthrow, another element of destruction came into play. The domestic fires of the various houses being scattered in all directions, inflamed the timbers, and a vast conflagration was the result, completing the wreck of the city. For four days this dreadful fire continued; but there was mercy mixed with this additional calamity, for thousands of corpses were consumed, which would otherwise have tainted the air and added pestilence to the survivors. In the midst of all these dreadful calamities, King Joseph, and his excellent minister, the Marquis Pombal, did much to alleviate the universal distress of the people.

No less than sixty thousand persons perished by this terrible catastrophe. The shocks, Ponton says, were felt all over the Spanish Peninsula, and about twenty-four miles from the city of Morocco there is said to have happened a catastrophe even worse than the sinking of the marble quay at Lisbon; for a fissure opened in the earth so wide that a whole village near Morocco, containing upwards of eight thousand inhabitants, was in a moment precipitated into the gulf, which closed over them.

The portion of the Earth's surface convulsed by this earthquake is estimated by Humboldt to have been four times greater than the whole extent of Europe. It was felt as far as the West Indian islands of Antigua, Barbadoes, and Martinique, where the tide, which usually rose but two feet, was suddenly elevated above twenty feet, the water at the same time being as black as ink.

Towards the north-west the shock was felt as far as

Canada, whose great lakes were all disturbed. In an easterly direction it extended to the Alps, and northward it reached the British Isles, the shock being sensibly felt at Cork.

All these facts, Ponton says, tend to show that the convulsion which produced the great Lisbon earthquake must have had its origin at a vast depth under the bed of the Atlantic, somewhere off the coast of Portugal, and that the disturbance must have been of a very violent kind.

It was several months before any of the citizens could summon courage to begin rebuilding the city. At first houses of wood were erected; but at length confidence returned, and then they set about the task with so much energy that ten years afterwards Lisbon was again one of the most beautiful capitals of Europe.*

In 1783, only twenty-eight years afterwards, the Calabrian earthquakes took place; which, though they were far less extensive, were more severe in local intensity, and continued for a longer time, and therefore had their origin at a more moderate depth.

There is one story connected with these earthquakes that I must relate, for it is of thrilling interest, as it shows the strength of a mother's love, even in the midst of the most terrible disasters.

The Marchioness of Spadara was sitting with her husband in their mansion, unsuspecting any danger, when suddenly they heard dreadful noises underground, and the house began to shake and totter. A giddiness seized her, and she fainted. The Marquis, with much presence of mind, snatched her up in his arms and carried her off to the harbour. The sea-breezes revived her, and on coming to herself she observed that her infant boy had been left behind. She felt that life without her child would be unbearable, and whilst her husband had

* See Appendix (page 470) for a letter from a relative of an ancestor of Mr. Bristow, who was residing in Lisbon during the earthquake.

gone a little way along the beach to look for a boat to convey them out of danger, she darted back to her house, which was still standing, and fled to the nursery, where she found her babe in his cradle unhurt. Snatching him up, she rushed towards the staircase; but what was her consternation to find that it had fallen, barring all further progress in that direction. She fled from room to room until she reached a balcony as her last refuge, and holding up her infant son, implored the passers-by to help her to save him. They, alas! were too concerned for their own safety to attend to her cries. In a short time the mansion caught fire, and her agonising cries were heard by some who would willingly have saved her if they had had the power; but another shock hurled the balcony into the devouring flames, and with it the devoted lady, grasping her darling boy, who thus perished with his loving mother.

Before dismissing this subject I would just revert to the great loss of human life by earthquakes; for, alas! we find that, great as the number is of those destroyed in these convulsions, it is an infinitesimal fraction compared with the destruction of life by man himself. If the numbers slain in battle for the last 2,000 years were to be added up, the total would be so appalling that we should not be able to form the slightest conception of the enormous figures. During the wars of Napoleon it is said that more than a million of men lost their lives; and if in twenty years the sinful ambition of one man resulted in the sacrifice of such hecatombs upon hecatombs, what must be the number slain from Hannibal to the present time?

Earthquakes should be looked upon as natural phenomena, arising from the operation of forces which are doubtless designed to accomplish some great and important end, and are therefore not incompatible with Divine benevolence.

There are other and gentler ways in which land is raised

above the surface of the sea, and one of them is the formation of islands and rocks by corals, which I shall speak fully of by-and-by.* I will just notice, however, before concluding this chapter, the gradual upheaval of large tracts of land without any paroxysmal phenomena accompanying it; tracks so upheaved are called

Raised Beaches.

At the present time parts of Norway and Sweden are from 100 to 200 feet higher above the level of the sea than they at one time were, and they are still slowly being raised at the rate, in some districts, of four feet in a century. This has been ascertained from the measurement of landmarks above the sea at various intervals, and from immense deposits of marine silt, containing the shells of mollusca now living in the Baltic, being found at the elevation above named.

One of these beaches is six miles from the present shore, and in some parts as much as 400 or 500 feet above the sea. There exist songs of ancient bards which celebrate the exploits of warriors when they went to fish for sea-calves in positions which are now far above the height that any such animals could climb. Although the gradual elevation of the land is evident, I dare say the Swedes are not much concerned about it; for during their lives and those even of their children's children the probable rise will be too small to affect them. Japan seems to be slowly rising in like manner.

Raised beaches are found all over the world. At Plymouth there is one, the maximum elevation of which is about thirty feet. Similar raised terraces of marine detritus, containing shells of existing species, occur in many places along the south and west coasts of England, at various points of the Scottish shores, and on those of France, Italy, Greece, the Cape of Good Hope, and the West Indies. Sometimes severa

* See page 244.

of these terraces are found one above another; on the Isle of Jura, for instance, there are six or seven lines of them, the lowest on a level with high water, and the highest forty feet above it.

We thus see that the great processes of upheavals and subsidences are going on still, both by violent and gradual stages: *we can, therefore, learn much of the past by the study of the present.*

This has brought us a step forward in the Biblical story of Creation. I have shown that there was a time when the universal ocean encompassed the Earth, and that then came the period of a distinct division between land and water, agreeing in its order precisely with the relation by Moses; though whether he saw in his vision any of the great convulsions, or whether he simply looked upon the rocks already elevated from the sea, we cannot tell. His mentioning, however, the gathering together of the waters to form seas, would seem to imply that he was privileged to witness these grand spectacles; and if so, we can quite understand how intensely his soul must have been filled with wonder, with awe, yea! with admiration of the Creator's power, "who spake, and it was done."

CHAPTER V.

"Let the Earth bring forth."

THERE are two great difficulties in the account given in our Bible of the vegetable creation. The words are—

"*Let the Earth bring forth grass, the herb yielding seed, and the fruit tree yielding fruit.*" (Gen. i. 11.)

First, Geology teaches us that the earliest forms of vegetation were *not* grass, herbs, and fruit-trees, such as now exist in such abundance.

The second difficulty is still greater, for many think that Moses intimates the existence of fruit-trees *before* the creation of the Sun; which is contrary to common sense and utterly inconsistent with fact.

These two difficulties I will endeavour now to solve.

The first is a question of translation; and if our version be the *correct* one, then the evidence of Geology is wrong.

The revelations, however, of Geology cannot err, for they are indelibly written in the rocks. Shall we then throw up our Bible, and pronounce the whole story a series of inconsistencies? Nay! rather let us study it carefully, and see whether the wise and learned men who in King James's reign conferred so inestimable a boon upon us all did not sometimes mistranslate a word, and at others, from their slight acquaintance with science, choose meanings for the Hebrew words which were inappropriate and even inconsistent with the circumstances.

I think I cannot better illustrate this last statement than by relating that, when a very young man, I was challenged

by an infidel to explain the second verse of the eleventh chapter of Exodus:—

"*Speak now in the ears of the people, and let every man borrow of his neighbour, and every woman of her neighbour, jewels of silver, and jewels of gold.*"

"There," said he, striking the Bible, "does not that book teach men to steal? You say that God is omniscient: if so, He knew that the Israelites would never return to Egypt; and by telling them to *borrow* what they never would repay, He gave them directions to steal." I showed him Kitto's note upon this passage, in which he explains that—

"The word *borrow* is an exceedingly unfortunate rendering of the Hebrew word שָׁאַל (*shāal*). But this rendering is quite peculiar to our version. The proper meaning of the term here is *to ask* or *demand;* and Horne states that it is so understood in every ancient version, and in every modern version except our own. The fact would seem to be that the Hebrews were instructed to take advantage of the consternation of the Egyptians at the death of the first-born, to demand compensation for having been so long obliged to labour without wages in their service."

There are many passages throughout the Old Testament where our translators have rendered this word *asked*, but one will suffice—1 Sam. viii. 10, "And Samuel told all the words of the Lord unto the people that *asked* of him a king."

In our own language how many words there are which have several, and apparently different, meanings. Take, for instance, the word "spring." We say the *spring* has come, meaning that season of the year has arrived; then we say, put a new *spring* into my watch, meaning the fixture of an elastic piece of steel; and again, he fetched the water from the *spring*, and with a *spring* leaped across the chasm. Varied as these meanings are, they can be traced to a common origin, and do not differ from one another so much as at first

appears; but a foreigner looking up the word *spring* in a dictionary for the first time, when attempting to translate an English book, would be somewhat puzzled to know which meaning to select until he had mastered the sense of the passage. Nor is this peculiar to our own tongue; every language abounds more or less with such diversities. We must grant, therefore, that the translators of our Bible, with all their care and with all their wisdom, might sometimes choose unsuitable words. These errors, however, are comparatively few; and all the important moral principles of the Bible are so plain and clear that "he may run that readeth." What I wish to illustrate by this digression is that the difficulties which are sometimes raised and quoted by unbelievers as insuperable may frequently be brushed away with an explanation of the meaning of the original text.

Some men are truly glad to lay hold of such an apparent inconsistency as grass, herbs, and fruit-trees flourishing before the Sun shone upon the Earth, in the very first chapter of the Book which Christian men so revere. Doubtless many have seen the triumph in their eyes when they have brought forward this argument, fully thinking that there was no reply which could clear up so detrimental an allegation.

It is true geologists show that in the early periods of the world's history the vegetation was of a very different kind from that mentioned in the text, and that if such a passage is to be understood as it usually is, then Science and Revelation are at variance, at any rate as far as the order of the events is concerned; for it seems pretty certain that true grasses, such as the corn-bearing plants of the agriculturist, which form the staple article of human food, and the humbler variety of the same order, which furnishes sustenance for grazing animals, did not appear until the Cretaceous period; and fruit-trees, such as the plum, the walnut, the vine, and

some others, are not found until the Miocene; whereas, according to Agassiz, the apple, the pear, the quince, the cherry, the peach, the apricot, the nectarine, the almond, the raspberry, the strawberry, and the various bramble-berries, together with all the roses and potentillas, were introduced only a short time previous to the human race.

This, then, is very clear and decisive, and would seem to be evidence dead against the Mosaic order; but I hope to show that the reverse is the case, and that Agassiz helps us very much indeed, as will be seen in the sequel, when I speak of God's planting a garden for man's enjoyment.

For the present, I will show that a better translation of the verses relating to the advent of vegetable life will prove the marvellous correctness of Moses' statements. I would just say that in endeavouring to give a more suitable rendering of this and other passages, I have consulted high authorities, and have been aided by some of our most eminent scholars, whom I have mentioned in my preface. These gentlemen confirm Dr. Kitto's explanation of this verse, that the word דֶּשֶׁא (*dēshĕ*), translated "grass," is applicable to every kind of verdure in the state of sprouting.

Secondly, that עֵשֶׂב (*'ēsĕbh*), rendered "herb," denotes a higher order of plants propagated by seeds, for Kitto says, the words "herb yielding seed" are very emphatic in the original; they are, literally, *herb seeding seed*, exactly imitated in the Septuagint version by *σπείρον σπέρμα*.

Thirdly, עֵץ פְּרִי (*'ēts p'rí*), "fruit-trees," may refer to certain trees of the Devonian and Carboniferous periods, some of which approached to true fruit-trees. Here, then, we get much light upon the matter; for such translations enable us to see that the Geological and Biblical statements are not at variance.

I have intentionally not noticed hitherto the various fauna and flora of the preceding strata, because I have

wished, as stated before, to describe in separate chapters the dawn of vegetable and animal life.

The exact period when plants first appeared cannot be told; for their delicate structure is such that their earliest forms may have been entirely destroyed. We may be certain, however, that they preceded animals; for as they can derive their nutriment and add to their tissues from inorganic matter, which animals cannot do, it would be necessary for them to have existed in some form first for animals to feed upon. Upon this I wish to lay particular stress; for animals and plants approach one another so nearly that it is sometimes difficult to say to which kingdom a body may belong, for when first the *Volvox globator* was seen in the microscope it was described as a wonderful and beautiful animal organism; which some still think, whilst others assert that it belongs to the vegetable kingdom, to which belong the exquisitely-formed Diatomaceæ.

In my last chapter I especially noted that we must judge of the past by what we are able to learn of the present operations of Nature; so also we may form an opinion of the ancient by a study of the modern flora, which is divided into two great series, the Cryptogams and Phænogams.

The Cryptogams are the flowerless plants which are reproduced by minute spores instead of seeds: they are divided into three classes. The first class comprises Seaweeds, Lichens, &c. (Thallophytes); the second, Mosses and their allies (Anophytes); the third and highest, Ferns, Equisetaceæ, Club-mosses, &c. (Acrogens).

The Phænogams, or higher series, are also divided into three classes: the first (Gymnosperms) having naked seeds, not covered like true fruit, and the woody tissue of simple structure, such as the Pines and Cycads; the second (Endogens) including the Palms and Grasses and their allies; the last and highest (Exogens) comprising the ordinary

timber-trees and other plants allied to them, with exogenous stems, netted-veined leaves, and a two-leaved embryo.

The first forms of vegetable life were evidently Cryptogams, which are propagated by spores and not by seeds; therefore, Moses has described them most correctly by simply speaking of them as "*sproutage*,"* without mentioning any seed.

Fig. 26.

Fig. 27.

Cryptogamic Plants of the Palæozoic Period.
Fig. 26.—Algæ. Fig. 27.—Lycopods.

As far down as the Laurentian rocks graphite has been found, of which many geologists entertain the opinion that it is of vegetable origin. Sir William Dawson says:—

"In any case the quantity of carbon which has been accumulated in the Laurentian rocks is very great. I have measured one bed at Buckingham, on the Ottawa, estimated to contain 20 per cent. of carbon, and which is at least eight feet in thickness. Sir William Logan has described another similar bed from ten to twelve feet thick; and more recent reports of the Geological Survey of Canada mention a bed supposed to be 25 feet

* The word "grass" in Gen. i. 11, 12, should have been translated "sproutage."

thick, in which Mr. Hoffman finds 30 per cent. of carbon. On the whole, the quantity of carbon in the graphitic zone of the Laurentian is comparable with that in certain productive coal-fields; and we certainly have in the subsequent geological history no examples of such accumulations, except from remains of the luxuriant vegetation of swampy flats."

With regard to this vegetation, it would imply the existence of sunlight, though some of the lower orders would require but little; still, that little was necessary. Let me, however, call your attention to the difference between sunlight and sunshine; for I think I shall presently show from the highest authorities that there was but little of the latter until after the Carboniferous period.

Sir William Dawson says that the Upper Laurentian and Huronian have as yet afforded no evidence of land vegetation; and he adds that he has not, after the most careful search, found it in the Upper Cambrian, although these rocks abound in the remains of sea-weed. But he has found land plants allied to Lycopods in the Upper Silurian, and he tells me, in a letter I have just received, that last year an insect was found in the Silurian of Spain, and a species of Scorpion was discovered in the Silurian of Sweden, Scotland, and America.

Before I refer to the fossil flora, I must just describe the

Old Red Sandstone,

which was not at first considered a separate formation; but Sir Roderick Murchison has clearly shown its right to an independent status, it having distinct lithological characters.

A distinguished foreigner said to him, "You must inevitably give up the Old Red Sandstone; it is a mere local deposit, a doubtful accumulation huddled up in a corner, and has no type or representative abroad." Sir Roderick replied, "I would willingly give it up if Nature would; but it assuredly exists, and I cannot." It is now universally admitted that the English geologist was correct in classify-

ing these strata as a separate system. It is one of the best-defined groups of rocks in Great Britain, though ill-developed in France and Germany; and hence the hesitation of the Continental geologists to consider it entitled to rank separately. It has been recognised in Scandinavia; it occupies vast areas in Southern Russia and the Western world. In South Wales it is 10,000 feet in thickness, and in North America 15,000 feet—that is, nearly three miles; and, therefore, a very long period must be allowed for its formation.

Dawson's description of the Devonian period, in "The Story of the Earth and Man," is so charming that I feel I must give it almost *verbatim*. He says, the period of the Lower Devonian "was one of powerful igneous activity. Volcanoes poured out their molten rocks over sea and land, and injected huge dykes of trap into the newly-formed beds. The land was shaken with earthquake throes, and was subject to many upheavals and subsidences. Violent waves desolated the coasts, throwing sand and gravel over the flats and tearing up newly-deposited beds; and poisonous exhalations, or sudden changes of level, often proved fatal to immense shoals of fishes. . . . . Sand and mud and pebble banks were almost universal over our two great continental plateaus in the Older and Newer Devonian. But in the Middle there were in some places deeperwaters with coral reefs; in others, shallow flats and swamps rich in vegetation. Herein we see the greater variety and richness of the Devonian. Had we lived in that age we should not have seen great continents like those that now exist, but we could have roamed over lovely islands with breezy hills and dense lowland jungles, and we could have sailed over blue, coral seas, glowing below with all the fanciful forms and brilliant colours of polyp life, and filled with active and beautiful fishes. Especially did all these conditions culminate in the Middle Devonian,

when what are now the continental areas of the northern hemisphere must have much resembled the present insular and oceanic regions of the South Pacific."

In various localities the Old Red Sandstone exhibits a countless profusion of singular depressions, in the form of rings and horse-shoes, of a pale yellow colour. These are small in English districts, but often nearly a foot in diameter in Scotland; their origin is obscure.

Milner, in his "Gallery of Nature," says the superstition of the folks residing on the English borders converted these appearances into supernatural phenomena. According to their tradition, a mare and her foal belonging to the Chapelry of Sapey having been stolen by a woman, who led them down the bed of a stream to avoid the discovery of their tracks, the patron saint interposed, and ineffaceably imprinted upon the rock the marks of the animals' feet and those of the woman's pattens, as a memorial of the sacrilegious crime.

"In the Devonian age," Sir William Dawson says, "we meet with no land-plants of the two lower classes of the Cryptogams, and with scarcely any that can be referred to the two higher classes of Phænogams; so that the vegetation of this period presents a remarkable character of mediocrity, being composed almost entirely of the highest class of the flowerless plants and the lowest class of those that flower. Of the former there are Tree-ferns and vast numbers of herbaceous forms, great Lycopodiaceous plants, immensely better developed than those now existing, and gigantic Calamites, allied to the Mares'-tails, along with humbler members of the same group." ("Chain of Life," p. 96.)

The Fern Tribes

succeeded the lower orders of Cryptogams, and appear to have been found as far down as the Silurian strata.

In reference to the flora of the Carboniferous period, Brongniart says that out of 500 species of plants found in the Coal Measures, 250 are Ferns, that is, 50 per cent.;

whereas botanists tell us that the various species of Ferns now in existence bear to the other species of plants the small proportion of about 3 or 4 per cent. Of these Ferns some grew

Fig. 28.—Ferns restored.

1 and 2, Arborescent Ferns; 3 and 4, Herbaceous Ferns.

into large trees, of which Fig. 28 gives restored representations. And Fig. 29 is a drawing of *Neuropteris gigantea*, of which I received from Professor Tennant a most beautiful specimen, with the veins of the leaves wonderfully preserved.

Not a few of the more anomalous forms of the Coal Measures seem to be Fern allies of the types Lycopodiaceæ, Marsileaceæ, and Equisetaceæ, which, instead of being mere herbs, shot up into trees. The Lycopods of our age are humble plants, scarcely a yard in height, and most commonly creepers; but those of the ancient world were trees of seventy or eighty feet in height. Both Hooker and Brongniart place the Lepidodendra with the Lycopods, from their having spores and sporangia like that family. Their leaves were sometimes very long, and their trunks often a yard in diameter. I give the representation of one which was found in the Jarrow Colliery, near Newcastle, lying on shale parallel to the planes of stratification; it is nearly fifty feet long (Fig. 30). This must have been a splendid tree when living, and perhaps not less than seventy feet to the topmost branch. Fig. 32, on page 154, is a restoration, which will give some idea of its appearance when living.

Fig. 29.—*Neuropteris gigantea.*

Our club-mosses or Lycopods, the nearest allies to these

fine trees, seldom stand erect; there is one, however, the *Lycopodium densum* of New Zealand, which attains the height of three feet.

Another beautiful tree of this period was the Calamite, related to our marsh plant, the Equisetum, commonly called

Fig. 30.—*Lepidodendron Sternbergii* in Jarrow Colliery.

the Mare's-tail. The Calamites grew from twenty to thirty feet high, and were from four to six inches in diameter. The engraving (Fig. 31) represents one or two beautiful restorations, from Dawson's "Chain of Life," of these gigantic Mares'-tails. They grew in dense brakes on the sandy and muddy flats, or perhaps even in the water, and had the power of budding from the base of the stem.

The Sigillariæ formed a numerous genus in the Carboniferous period, and were the most important of all the

Fig. 31.—*Calamites* (Carboniferous).

A. *C. Suckovii.* A¹. Foliage. A². Ribs and Scars. A³. Roots. A⁴. Base of Stem. B. *C. Cistii.* B¹. Leaves. D. Structure of Stem. E. Vessels Magnified.

trees of the coal-swamps and those which contributed most largely to the production of coal.

Fig. 32.—*Lepidodendron Sternbergii* (restored).

From their external structure they were formerly thought by Brongniart to belong to the Fern tribes; but their internal

organisation resembled that of the Cycads. They grew to a great height—from thirty to sixty and even seventy feet—and were remarkable for their beautifully sculptured stems, varying in their pattern according to the species. All were fluted vertically, somewhat like Grecian columns, and each fluting had its line of sculpture running down its centre. In Fig. 33 I give a drawing of a piece of bark of *Sigillaria lævigata*, showing the beautiful markings of the stem.

The roots of this tree were once supposed to be a distinct

Fig. 33.—*Sigillaria lævigata* (one-third natural size).

Fig. 34.—*Stigmaria* (one-tenth natural size).

aquatic plant, and were called *Stigmariæ* (Fig. 34). The connection of the roots with the stem, previously suspected on botanical grounds by Brongniart, was first proved by their discovery in actual contact in the Lancashire coal-field, by Mr. Binney. Sometimes these roots (Fig. 34) extend sixteen feet.

There is another very graceful plant which I must notice, *Asterophyllites foliosa* (Fig. 35). This seems to have been an aquatic plant, and the leaves under the water were, according to some writers, of different shape from those above it. M. Brongniart supposed, from its pith and medullary rays, that it was dicotyledonous, and allied by the nature of its tissue to the Sigillariæ.

Another beautiful tree (Fig. 36) was the Sphenophyllum, growing some twenty or thirty feet in height; and Dawson says that the stems were very slender, branching copiously, with wedge-shaped leaves, often toothed at the edges, and veined in the manner of fern-leaves. Five species have been recognised in the Acadian coal-fields.

The Coniferous trees of this period are referred to several genera; the woody structure of some of them showing that they were more allied to the Araucarian division of pines than to any of our common European firs. Some of the trunks

Fig. 35.—*Asterophyllites foliosa.*

exceeded forty-four feet in height. Many, if not all of them, seem to have differed from living Coniferæ in having large pith; and plants of this order lay claim, if not to the highest, at least to so high a place in the scale of vegetable life as to preclude us from characterising the Carboniferous flora as consisting of imperfectly-developed plants.

Here I must endeavour to clear up another difficulty. It will be noticed that though I give other meanings to the words translated "grass" and "herb," I still adhere to the term

"Fruit Trees,"

עֵץ פְּרִי (*'ēts p'rí*); but instead of there being an error in point of time, I can show that both in the Devonian and

Carboniferous periods there existed numerous trees of the Coniferous order, the seed-vessels of some of which might be properly styled fruit. The following engraving (Fig. 37)

Fig. 36.—Sphenophyllum restored by M. Eugène Deslongchamps.

from Dr. Dawson's admirable little book, "The Chain of Life,"* will give you a very good notion of them. I cannot too strongly recommend this work to my readers, for it is written in a popular style, and can be thoroughly depended upon for its scientific information. It will be seen that some of the seed-vessels were quite surrounded

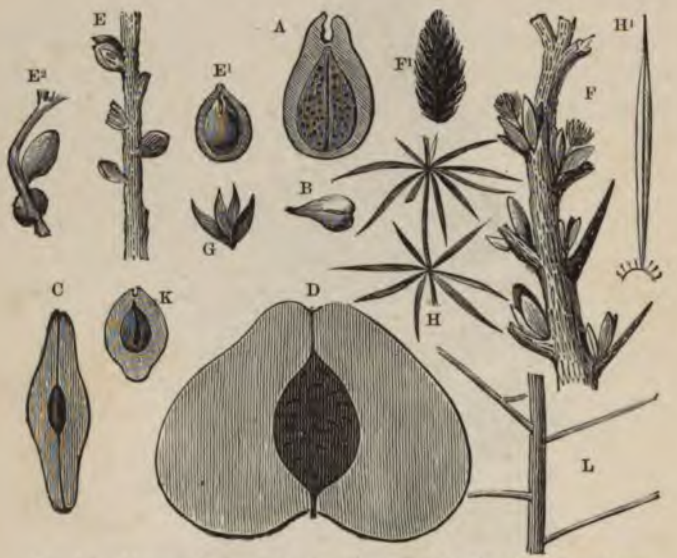


Fig. 37.—Group of Devonian Fruits, &c. Middle Devonian, New Brunswick.

A. *Cardiocarpum cornutum.*
B. *C. acutum.*
C. *C. Crampii.*
D. *C. Baileyi.*
E. *Trigonocarpum racemosum.*
E¹, E². Fruits enlarged.
F. *Antholithes Devonicus.*
F¹. Fruit of *A. Devonicus.*
G. *Annularia acuminata.*
H. *Asterophyllites acicularis.*
H¹. Leaf.
K. Cardiocarpum (probably the young of A).
L. *Pinnularia dispalans.*

with fleshy coatings, which might, as in the Ginkgo of Japan, have constituted edible fruits. Seeds of this type seem to have been extremely abundant in the Carboniferous age in all parts of the world, and were probably produced by trees of

* Religious Tract Society.

several genera (Dadoxylon, Sigillaria, Cordaites, &c.). Charles Brongniart has described no less than seventeen genera of these seeds from the coal-field of St. Etienne alone, and it would be a low estimate to say that we probably know as many as sixty or seventy species in all, while the trunks of great Coniferous trees allied to Taxineæ, and showing well-preserved structure, are by no means uncommon in the Devonian and Carboniferous rocks.

Of the fruit of this period I must especially mention that of the Trigonocarpon, which was formerly supposed to be the fruit of a palm; but Sir Joseph Hooker states that it may be referred to that large section of Coniferous plants which bear solitary fruits and not cones (E, E^1, and E^2, of Fig. 37).

The exterior integument is very thick and cellular, and was, no doubt, once fleshy. The second coat was thinner, but hard and marked by three ridges. This coating, being all that commonly remains in a fossil state, has suggested the name of Trigonocarpon. Within this were the third and fourth coats, both of which are very delicate membranes, and may possibly have been two plates belonging to one membrane. Lyell says its geological importance is great; for so abundant is it in the Coal Measures, that in certain localities the fruit of some species may be procured by the bushel.

"On the whole," Sir Joseph Hooker says, "these fruits are referable to a highly-developed type exhibiting extensive modifications of elementary organs for the purpose of their adaptation to special functions; and these modifications are as great, and the adaptation as special, as any to be found amongst analogous fruits in the existing vegetable world."

In Plate VIII., M. Riou has attempted, under the directions of M. Eugène Deslongchamps, to reproduce the aspect of Nature during the Coal period. On the right are seen the naked trunks of a Lepidodendron and a Sigillaria, an

arborescent Fern rising between the two trunks, and at the foot of these great trees is an herbaceous Fern. On the left is the naked trunk of another Sigillaria, whose foliage is altogether unknown; there are also a Sphenophyllum and a Conifer. It is difficult to describe with precision the species of this last family, the impressions of which are nevertheless very abundant in the Coal Measures.

"In front of this group we see two trunks broken and overthrown. These are a Lepidodendron and a Sigillaria, mingling with a heap of vegetable *débris* in course of decomposition, from which a rich humus will be formed whereupon new generations of plants will soon develop themselves. Some herbaceous Ferns and buds of Calamites rise out of the waters of the marsh. A few fishes belonging to the period swim on the surface of the water, and the aquatic reptile Archegosaurus shows its long and pointed head. The pretty Asterophyllites, with its finely-cut stems, rises above it in the foreground; whilst a forest of Lepidodendra and Calamites forms the background to the picture." *

To me it seems a most wise providence that these beautiful forms of vegetation should have been thus wonderfully preserved for millions of years, to tell us the story of those ancient forests, and to reveal to us the various steps of creation.

How little should we have known of the past if it had not been for the wise and excellent arrangement that both animals and plants should have been so embedded in the rocks that the most delicate vegetable tissues and minute animal organisms have been preserved uninjured!

Dr. Buckland, in his "Bridgewater Treatise," thus refers to the coal deposits of Bohemia:—

"The most elaborate imitation of living foliage upon the painted ceilings of Italian palaces bears no comparison with the

* "The World before the Deluge."

VIII.—Ideal View of a Marshy Forest of the Coal Period.

beauteous proportions of extinct vegetable forms with which the galleries of these instructive coal-mines are overhung. The roof is covered as with a canopy of gorgeous tapestry, enriched with festoons of a most graceful foliage, flung in wild, irregular profusion over every portion of its surface. The effect is heightened by the contrast of the coal-black colour of these vegetables with the light ground-work of the rock to which they are attached."

The Climate of the Devonian and Carboniferous Periods.

Sir Andrew Ramsay, in his splendid and most comprehensive address before the British Association of 1880, stated that glacial phenomena could be discovered to have taken place as early as the Cambrian epoch; and he gives as his reasons for thinking so that, in the north-west of Scotland, mammillated surfaces of Laurentian gneiss pass under Cambrian sandstone containing large angular blocks at its base; he also states that he saw erratic blocks of gneiss and granite embedded in the Lower Silurian graptolitic rocks at Corswall Point, in Wigtonshire. He adds, however :—

"If any one will point out any other natural cause still in action by which such results are at present brought about, I should be very glad to hear it."

I would scarcely dare to enter the lists in opposition to so profound a philosopher; although I think that some other cause will be found to explain these phenomena. For it seems to me that such glacial epochs could not have taken place until after the Carboniferous period, because during that time the temperature all over the globe appears to have been a humid and warm one; which might perhaps be accounted for by the internal heat still rendering the surface considerably warmer than it is now, and by the amount of carbonic acid in the atmosphere.

I do not think, however, that this will affect the chief point I wish to prove—namely, that the Sun, up to the Car-

boniferous period, was for the most part concealed from the Earth by the density of the atmosphere, which was saturated with aqueous vapour. Such a condition, however, would not be inconsistent with intense cold on elevated positions; just as we now find ice and snow on the tops of mountains in the hot countries of equatorial latitudes.

Bristow and Figuier, when noticing this point, say :—

"That such a state of things is not inconsistent with the prevalence of a moist, equable, and temperate climate, necessary for the preservation of a luxuriant flora like that of the period in question, is shown in New Zealand, where, with a climate and vegetation approximating to those of the Carboniferous period, there are also glaciers at the present day in the southern island."

I will now give the opinions of four eminent geologists upon the climatic condition of the Earth during the Carboniferous period.

Hugh Miller, on page 166 of his "Testimony of the Rocks," says :—

"It is now ascertained, from the circumstance that no dew is deposited in our summer evenings save under a clear sky, that even a thin covering of cloud—serving as a robe to keep the Earth warm—prevents the surface heat of the planet from radiating into the spaces beyond. And such a cloud, thick and continuous, as must have wrapped round the Earth, as with a mantle, during the earlier geologic periods, would have served to retard for many ages the radiation, and consequently the reduction, of that internal heat of which it was itself a consequence. . . . Nor would a planet covered over for ages with a thick screen of vapour be a novelty even yet in the universe. It is doubtful whether astronomers have ever yet looked on the face of Mercury; it is at least very generally held that hitherto only his clouds have been seen. Even Jupiter, though it is thought his mountains have been occasionally detected raising their peaks through openings in his cloudy atmosphere, is known chiefly by the dark shifting bands that, flecking his surface in the line of his trade-winds, belong not to his body, but to his thick dark covering. It is

questionable whether the human eye on the surface of Mercury would ever behold the Sun, notwithstanding his near proximity; nor would he be often visible, if at all, from the surface of Jupiter. Nor, yet further, would a warm, steaming atmosphere, muffled in clouds, have been unfavourable to a rank, flowerless vegetation like that of the Coal Measures.

"There are moist, mild, cloudy days of spring and early summer that rejoice the heart of the farmer, for he knows how conducive they are to the young growth on his fields. The Coal-Measure climate would have consisted of an unbroken series of these, with, mayhap, a little more of cloud and moisture and a great deal more of heat. The Earth would have been a vast greenhouse covered with smoked glass, and a vigorous, though, mayhap, a loosely-knit and faintly-coloured vegetation would have luxuriated under its shade."

You have noticed, doubtless, that Hugh Miller mentions that Jupiter is thought to be enveloped in a thick cloudy atmosphere. Well, I have something deeply interesting to tell you about this. In the course of a conversation with an eminent astronomer, I asked him whether from his spectral observations he thought any of the light from Jupiter was from its own incandescence, or whether it was all reflected sunlight. He said that the planet might still be very hot, and give out some continuous light, but he thought that it was principally, if not all, reflected light, and that its brightness might arise partly from its great size and partly from the nature of its atmosphere.

The same gentleman has most kindly furnished me with the following calculation by Zöllner, giving the light-reflecting power of different terrestrial substances as compared with that of the Moon and planets seen through a telescope:—

Terrestrial Substances.		*Planets.*	
Fresh snow, 0·7830		Uranus, 0·6406	Neptune, 0·4658
White paper, 0·7000		Jupiter, 0·6238	Mars, 0·2672
Sandstone, 0·2370		Saturn, 0·4981	Moon, 0·1736

Here, then, we have the reflecting power of Jupiter nearly equal to that of white paper; Saturn and Neptune rank next in their power of reflecting light, but Uranus even exceeds Jupiter in this respect. The Moon, we find, reflects less light than sandstone, and Mars only a little more. The lesson taught us by all this is most clear and plain—namely, that all these giant worlds have not yet cooled down to the condition of the Earth, the Moon, or Mars, and that they are still surrounded, as I have said the Earth was in its early stages, with a dense watery vapour, which reflects the sunlight similarly to our clouds when the Sun's rays are falling directly upon them.

Lyell, on page 501 of his "Elements of Geology" (6th edit., 1865), says:—

"So long as the botanist taught that a tropical climate was implied by the Carboniferous flora, geologists might well be at a loss to reconcile the preservation of so much vegetable matter with a high temperature; for heat hastens the decomposition of fallen leaves and trunks of trees, whether in the atmosphere or in water. It is well known that peat, so abundant in the bogs of high latitudes, ceases to grow in the swamps of warmer regions.

"It seems, however, to have become a more and more received opinion that the coal-plants do not, on the whole, indicate a climate resembling that now enjoyed in the equatorial zone. . .

"A great predominance of ferns and lycopodiums indicates *moisture, equability of temperature,* and *freedom from frost,* rather than intense heat; and we know too little of the Sigillariæ, Calamites, Asterophyllites, and other peculiar forms of the Carboniferous period, to be able to speculate with confidence on the climate they may have required."

Figuier, on page 133 of "The World before the Deluge" (edit. 1872), says:—

"*Let* us pause for a moment, and consider the general *characters which* belonged to our planet during the Car-

boniferous period. Heat—though not necessarily excessive heat—and extreme humidity were the attributes of its atmosphere. The modern allies of the species which formed its vegetation are now only found under the burning latitudes of the tropics; and the enormous dimensions in which we find them in the fossil state prove, on the other hand, that the atmosphere was saturated with moisture.

"Dr. Livingstone tells us that continual rains, added to intense heat, are the climatic characteristic of Equatorial Africa, where flourishes the vigorous and tufted vegetation which is so delightful to the eye.

"It is a remarkable circumstance that conditions of equable and warm climate, combined with humidity, do not seem to have been limited to any one part of the globe, but the temperature of the whole seems to have been nearly the same in very different latitudes. From the equatorial regions up to Melville Island, in the Arctic Ocean, where in our days eternal frost prevails—from Spitzbergen to the centre of Africa, the Carboniferous flora is identically the same.

"When nearly the same plants are found in Greenland and Guinea; when the same species, now extinct, are met with of equal development at the equator as at the pole, we cannot but admit that at this period the temperature of the globe was nearly alike everywhere.

"What we now call *climate* was unknown in these geological times. There seems to have been then only one climate over the whole globe.

"It was at a subsequent period, that is, in later Tertiary times, that the cold began to make itself felt at the terrestrial poles. Whence, then, proceeded this general superficial warmth, which we now regard with so much surprise? It was a consequence of the greater or nearer influence of the interior heat of the globe. The Earth was still so hot in itself that the heat which reached it from the Sun may have been inappreciable."

Dr. James Dana, Professor of Geology, Yale College, U.S., on page 352 of his "Manual of Geology," third edition, 1881, says:—

"Through the whole hemisphere—and we may say, world—

there was a genial atmosphere for one uniform type of vegetation, and there were genial waters for Corals and Brachiopods. A warm state of the globe would necessarily imply a very much larger amount of evaporation than now. The climate would be insular throughout, and heavy mists would rest over the land, making the air and land moist. The comparatively small diversity of climate between the equator and poles would probably be attended with fewer storms than now, and a less rapid movement in the general circulation."

I have intentionally chosen the opinions of geologists who may be said to represent four different periods in the advancement of the science.

Hugh Miller wrote his "Testimony of the Rocks" in 1856. The edition of Lyell's "Elements of Geology," from which the second passage, quoted above, was taken, was published in 1865. Figuier's work, "The World before the Deluge," was edited in 1872 by Mr. Bristow, Director of the Geological Survey of England and Wales, and the preface tells us that many important additions were made by him, the result of the recent investigations of himself and his colleagues. The opinion of Dr. Dana, taken from his "Manual of Geology," is as late as 1881.

I might here mention that I am indebted to Figuier's book for some of the illustrations in this work. I wish to add, however, that I have quoted from it several times in consequence of its having been edited by Mr. Bristow, to whose opinion I attach much value.

Let us now examine these four opinions. Miller speaks of the thick cloud which wrapped round the Earth, as with a mantle, during the earlier geologic periods, and compares the Earth to a vast greenhouse covered with smoked glass.

If my readers will pay a visit to Kew Gardens, they will find that the larger number of the fern-plants are in greenhouses, from which the direct rays of the sun are cut off by *thick glass, coloured* green, and that the temperature is kept

up at an equable warmth the whole year round, whilst the atmosphere is saturated with moisture.

Judging, therefore, from the climate and temperature necessary for a great number of the Fern tribes with which we are acquainted, we may surely with justice reason that those of the Coal Measures would require similar conditions for their growth.

Lyell, we find, gives us good reasons for believing that the climate was not like that of our present equatorial zone, but rather one of an equable, warm temperature, accompanied with much moisture.

Figuier assumes that the heat was greater than that supposed by Lyell; but still he says that it was not necessarily excessive. He mentions as one reason for the probable warm temperature that the modern allies of the plants of that period are now only found under the tropics, but he adds that the enormous dimensions in which we find them in the fossil state prove that the atmosphere was saturated with moisture. Dana is evidently of the same opinion. Dr. T. Sterry Hunt believes that in these earlier geological periods there was much carbonic acid in the atmosphere, which would conduce to a warm and equable temperature.

I called your attention just now to the operations of Nature in our Fern Conservatory at Kew, but I will give you a still more interesting fact which will aid us in these considerations. In the Pacific Ocean, off the coast of Chili, there is an island named Chiloë, where it rains 300 days in the year, and where the light of the sun is shut out by perpetual fogs. On this island "arborescent ferns form forests, beneath which grow herbaceous ferns, which rise three feet and upwards above a marshy soil, and a mass of cryptogamic plants flourish there, resembling in its main features the flora of the Coal Fields."

Please to notice a most important statement of Dana, that this warm and humid climate was nearly the same in

every part of the globe, and that the flora and fauna were of a uniform type throughout. That one climate prevailed all over the world most strongly confirms all the previous theories of the warmth arising from the internal heat as well as from the Sun, which seems to have been much concealed by cloudy vapours during this and the previous periods.

This universality of the same climatic condition of the Earth is, I think, also one of the strongest arguments in favour of the theories I shall propose in the next chapter; when I shall endeavour to prove that before this period there were no seasons, in our sense of the term, but that after this epoch the Sun, Moon, and Stars were appointed "*to rule over the day and over the night*," and "*to be for signs, and for seasons, and for days, and years.*"

Coal and Coal-Mines.

That the vegetable growth must have been prolific in the extreme may well be understood when we consider the immense quantity of coal in the coal-seams throughout the world. Lyell gives the amount in the coal-fields of one district alone—that of Nova Scotia—as being not less than 51,000 cubic miles of solid carboniferous rock, and, though the pure coal portion of this would not be more than 150th of the whole, yet it would be sufficient to last for fifteen thousand years, if used at the rate of a hundred million tons a year.

We cannot but feel somewhat staggered at this enormous quantity, and naturally ask how such deposits came about.

Some have thought that the coal-beds result from the transport by water, the submergence and burial of immense rafts formed of the trunks of trees. There are several reasons why this hypothesis is not tenable.

In the first place, such accumulations of wood could never have arranged themselves with sufficient regularity to *form these* well-stratified coal-beds, maintaining a uniform

thickness over many miles; which, too, are seen in most coal-fields to lie one above another in succession, separated by beds of sandstone and shale.

Secondly, if the coal had been formed by the slow and gradual accumulation of vegetable *débris*, like that which reaches the mouth of a river, then such plants would be buried in great quantities of mud and earth: we find, however, that in most of our coal-seams the proportion of earthy matter rarely exceeds 15 per cent. of the entire mass.

Thirdly, the incredible quantity of vegetable matter which must have accumulated together at one time to form the seams of coal is a still stronger argument against the supposition; for Figuier has made the calculation that, in consequence of the great reduction in volume of vegetable matter when formed into coal, these accumulations must have been 310 feet thick to form a bed of coal 16 feet in thickness.

And lastly, the remarkable parallelism existing in the stratification of the Coal formation, and the state of preservation in which the most delicate vegetable forms are discovered, most clearly demonstrate that the coal-seams were formed in perfect tranquillity, and that the mineralisation of the plants took place on the spot where the plants lived.

The purity of coal, and the absence of earthy particles and sand through areas of vast extent, for a long time puzzled geologists, especially as the plants of the Coal Measures evidently grew in swamps. This difficulty may, perhaps, be solved by attending to what is now taking place in deltas.

The dense growth of reeds and herbage which encompasses the margins of forest-covered swamps in the valley and delta of the Mississippi is such that the fluviatile waters, in passing through them, are filtered and made to clear themselves entirely before they reach the areas in which vegetable matter may accumulate for centuries, forming coal, if the climate be favourable. Thus in the large submerged tract called "The

Sunk Country," near New Madrid, forming part of the western side of the valley of the Mississippi, trees have been standing erect ever since the year 1811, killed by the great earthquake of that date; lacustrine and swamp plants have been growing there in the shallows, and several rivers have annually inundated the whole space, and yet have been unable to carry any sediment within the outer boundaries of the morass, so dense is the marginal belt of reeds and brushwood.

I mentioned just now that the coal was evidently formed during a tranquil state of the Earth; but though there do not appear to have been any violent commotions, still there must have been alternate movements of elevation and depression. These movements must, however, have been very gradual, like those I have mentioned and explained in the last chapter, and might not have exceeded one foot in a century; in which case, Lyell says that it would have taken a million of years to form the Coal Measure of South Joggins in Nova Scotia. How overwhelmed one gets when considering these enormous periods of time, and how trifling is the span of human life in comparison with them!

Let us endeavour to picture to ourselves one of these primeval forests, with all its thick and beautiful foliage, covering a district sinking less than one-eighth of an inch in a year. One thousand years would roll away before it would be ten feet below its original level; and ten thousand years would be required to entirely cover over the tall Sigillariæ. Nevertheless, it would all at last become embedded, and in the same place would spring up new forests, which in ten thousand years more would also be submerged. All the while a prolific vegetation would have been growing up; so that at the end of a million of years the thick coal-seam would be formed, first resembling the peat-moss of our moors and marshes, and afterwards, from the weight and pressure *of the superincumbent* mass, changed into coal. During the

deposition of the sandstone the subsidence was probably more rapid; less so during that of the shales, whilst the coal-seams represent periods of comparative rest. But in any case the time must have been very great.

Of course, during these processes "the vegetable matter would undergo a partial decomposition; a moist putrefactive fermentation would take place, accompanied by the production of much carburetted hydrogen and carbonic-acid gas, which would escape, and the carbon would become more concentrated. The heat emanating from the interior of the globe would also exercise a great influence upon the final result; and the quality of the coal would be affected by the amount of such heat combined with the superincumbent pressure."*

I must notice here that what we generally call the Coal Measures are composed only in very small part of solid coal.

If we trace the series of which a coal-field is composed, beginning with the lowest stratum, we have—

First, the underclay, a tough argillaceous substance which, upon drying, changes into a grey friable earth. It is sometimes black, from the presence of carbonaceous matter, and it contains innumerable stems of Stigmariæ, as already noticed. It is the *soil* on which the coal-plants grew.

Secondly, the coal, in which the external forms of plants are obliterated, although the structure is sometimes microscopically apparent.

Thirdly, the roof, or upper bed, which generally consists of slaty clay, abounding in leaves, trunks, stems, branches, and fruits of the Conifers, and often containing layers of iron-stone nodules in which leaves and other fossils are embedded. Interstratified with the shale, finely laminated clay, micaceous sand, grit and pebbles of quartz, and other rocks, occur.

* *Op. cit.*, p. 168, par. 3 from bottom.

In fact, the bed appears to be an accumulation of drifted materials mingled with the dense foliage and stems of a prostrate forest. These phenomena, as Dr. Mantell says, may be explained by supposing the inundation of a thickly-wooded plain by an irruption of the sea, or of a vast lake occasioned by the removal of some barrier, or by a subsidence of the tract of country on which the forest grew.

But when we find an accumulation of strata in which triple deposits of this kind are repeated some thirty or forty times, through a thickness of many thousand feet, a satisfactory solution of the problem is very difficult.

Subsidence after subsidence must have taken place, each followed by a period of rest; another soil fit for the growth of forest trees must have been produced, another generation of vegetables of precisely the same species and genera have sprung up and arrived at maturity, and then there must have been another subsidence and another accumulation of drift. And these oscillations of the relative levels of the sea and land must have gone on uninterruptedly through a long period of time; not in one district or country only, but all over the world, and during the same geological period.

In later geological periods there seem to have been great convulsions, which distorted and heaved up these Coal Measures; in some instances, by the subsequent removal, through "denudation," of the overlying rocks, bringing the seams even to the surface. Here again we see the wisdom of it all, for we should never have been able to reach the coal had the after-strata been allowed to remain permanently piled upon its top.

Doubtless many of these convulsions took place millions of years ago, as we learn from the disposition of the strata formed above the coal; and yet it was all a part of the great *scheme of providing* for the wants of the future Man.

The great necessity which coal is to us now leads us to wonder how our forefathers for thousands of years did without it. They did so, however; and an Act of Parliament was passed in 1306 forbidding its use. They thought that the bright and cheerful-blazing log was far superior to the smoke-giving mineral; and for their furnaces charcoal answered all the purposes required.

Steam-engines and locomotives were not then invented; and if they had been, only the large forests of the New World could have supplied them; very soon those of Europe would have been burnt up for fuel, and a desert waste would have been the consequence. In 1880 more than a hundred and forty-nine millions of tons of coal were obtained from the British coal-mines alone. In 1800 the amount was only ten millions. This looks indeed like progress in our commerce and manufactures.

In judging of a district, as to whether it will yield coal or not, the opinion of a geologist is necessary; for if the strata in the neighbourhood be any of those below the Carboniferous series, it would be useless to bore for coal.

George Stephenson was a great adept in this matter; and he turned it to good account when he bought Tapton, which was a mine of wealth to him.

The dangers attending upon coal-mining are very great; and one of the worst arises from the *fire-damp*, or light carburetted-hydrogen gas, which escapes from the coal-seams after having been pent up for ages.

This gas is sometimes called marsh gas, because it is generated in marshy places where the vegetable matter is decaying; and it is the cause of the will-o'-the-wisp. Any one may collect some of it by stirring up the bottom of a pond, and catching in a receiver the bubbles as they rise to the surface. The symbol for it is CH_4, and it is much lighter than the gas we burn, which is a mixture of marsh gas

and olefiant gas, or heavy carburetted hydrogen, C_2H_4, the latter being much heavier than the former.

Both these gases, when mixed with atmospheric air in certain proportions, become explosive; for on a flame coming into contact with the mixture, the oxygen of the air unites with the hydrogen of the gas to form water, H_2O, and with the carbon to form the deadly carbonic-acid gas, CO_2.

During an explosion the oxygen and hydrogen are converted (as before stated) into water, and, occupying some thousands of times less space, a vacuum is suddenly formed, into which the air rushes, causing a violent concussion.

In the case of gunpowder the same results are brought about by a sudden expansion of the solid gunpowder into a gas occupying 2,000 times the space, and in that of dynamite to 5,000 times its space.

Perhaps, as some books on chemistry give different figures from these, I had better quote from a letter I received from Lieut.-Colonel Duncan, of the Royal Artillery, upon the subject, Nov. 7th, 1881, in which he says:—

"Gunpowder, if it could be fully expanded into gas, at the moment of explosion would occupy a space about 2,000 times greater than it did before." *

From the experiments at the pond which I mentioned to you, it will readily be understood how much of this marsh gas must be shut up in the mines, and how very dangerous it is to the miners, especially when a blow of the pickaxe will sometimes set free so large a quantity that it rushes out of the aperture with a great noise, and is hence called a "blower." It abounds in some mines more than in others, and some cannot be worked in consequence of the impossibility of any light being carried into them.

Sometimes these "blowers" are constant in their action; in which case the gas is collected and conveyed by a tube into

* See Appendix (p. 473) on this subject.

the upcast shaft, continuing for months or years to pour forth hundreds and even thousands of cubic feet of fire-damp per minute.

When thus provided for, the "blowers" are not necessarily a source of danger; but when one of the reservoirs containing the pent-up gas of centuries, and consequently under an enormous pressure, is suddenly broken open, the gas is set free in torrents, and mingling with the air of the mine forms an explosive mixture which the first spark or naked flame may ignite, and thus cause a fearful destruction of life and property. The poor miner in an instant is scorched and shrivelled to a blackened mass, or is literally shattered to pieces against the rugged sides of the mine.

These explosions will always be liable to occur when the volume of marsh gas is one-eighth the volume of the air; and I wish you to notice this, for I shall refer to it again presently.

The light carburetted-hydrogen gas spoken of is by no means the most deadly one which the miners have to contend with, for after an explosion the floors of the galleries are covered with carbonic-acid gas, which immediately suffocates any of the poor fellows who may have been knocked down but not killed; hence it is called *choke-damp*.

In Stephenson's time these accidents were so numerous that he turned his whole attention to the means of preventing them. On one occasion, in 1812, no fewer than ninety men and boys were suffocated or burnt to death; his exclamation was, "The price of coal is pitmen's lives." What his efforts were to save them I will now relate.

George Stephenson and Sir Humphry Davy, without knowing anything whatever of each other, were in the same year endeavouring by similar experiments to contrive a safety-lamp; with this difference, however, that the miner was trying his experiments deep underground, in the dangerous

galleries of the Killingworth colliery, and the philosopher was working safely in his laboratory.

George Stephenson thought nothing of his personal danger, for he would frequently go into a pit and make his experiments close to one of the "blowers" before mentioned, and when remonstrated with would say, "I must save pitmen's lives." He also collected some of the gas in bladders, and tried many experiments at home in his cottage after his hard work for the day was done.

The point to be gained was, that when the gas in the gallery had become dangerous the flame of the lamp should not be able to explode it. In this, as is well known, he perfectly succeeded, and he found that by placing together a number of tubes of very small diameter, flame would not pass through them. These tubes he obtained by filing off the barrels of several small keys.

In reference to his lamp I will tell you an excellent story. Stephenson got a friend, Mr. Nicholas Wood, in the month of August, 1815, to make a drawing of one according to a description which he himself gave. After several evenings of careful deliberation, the drawing was made and shown to several of the head men about the works. Stephenson ordered a lamp to be made by a Newcastle tinman after his own plan, and at the same time he directed a glass to be made for it.

On the evening of the 21st of October he returned to his cottage just as it was getting dark, and found Mr. Moody, the under-viewer of the mine, and his own son, Robert, then only twelve years old, waiting for him. With a face all radiant he held up his lamp, and, his hands almost trembling with pleasure, he filled it with oil, trimmed it, and lighted it. When he saw it burning clearly and brightly, his eyes sparkled with joy, and turning to Robert he said, "Run to Beaton, and *tell* Nichol we are going down to the pit to try the lamp."

It was eleven o'clock before they all got to the mine, and the man at the pit's mouth had to be roused from his first sleep to let them down the shaft. They then proceeded to the foulest part of the mine, where gas was issuing through a "blower," and some deal boarding was erected round the gallery so as to confine the gas and render it more explosive. Then all retired to a distance, and waited for an hour until the gas had accumulated to such a degree that a light coming into contact with it would cause an instant and violent explosion.

Moody earnestly warned Stephenson of the danger he was running; but, lighting his lamp, George told them cheerfully that he was prepared to run the risk. They drew back farther, and he proceeded all alone towards the dangerous spot. Let us try to picture to ourselves this brave man pursuing his solitary way through those dark galleries at the weird hour of midnight, and carrying with him a lamp which would either prove itself to be a most valuable boon to the poor miners, or cause a catastrophe which might shatter him to pieces against the rough and jagged walls. But still on he goes, filled with noble and philanthropic thoughts which leave no room in his heart for an atom of fear. He approaches the barricade, and can hear the deadly gas issuing from the "blower;" still he flinches not, but steps within the awful enclosure, and sending up a prayer to his Heavenly Father, he watches the effect of the surrounding gas upon his lamp. Presently the flame grows dimmer and dimmer, and then goes out. Lifting up both his hands, he exclaims from the bottom of his manly heart, "Thank God! pitmen's lives are saved!"

He returned to his friends, joyously holding out his extinguished lamp, and told them of its complete success. Words cannot express the emotions of those three men at that moment. On the part of Stephenson, there was sincere thankfulness that his desire was accomplished and his life

spared; and on theirs, intense admiration of the noble deed of this courageous man.

They all tried the lamp several times, and morning was advancing before they left the mine.

George made several improvements in his lamp, and afterwards explained it to the Philosophical and Literary Society of Newcastle on the 5th of December, 1815.

A few days later, Sir Humphry Davy's novel lamp was received and exhibited to the coal-miners at Newcastle, on which occasion the observation was made by several gentlemen, "Why, it is the same as Stephenson's!" It differed, however, in several important particulars.

This was one of those remarkable instances which every now and then occur of two men, far apart from each other, discovering the same thing at the same time, each being unconscious of the other's labours.

There is no doubt that eventually Stephenson's lamp will be preferred, for its greater safety is in going out; whereas Davy's gets red-hot and burns the miners' hands, who sometimes by throwing their lamps down cause an explosion.

This was strikingly exemplified at the colliery pit at Barnsley on the 20th of August, 1857. A sudden outburst of gas took place from the floor of the mine along a distance of fifty yards. Fortunately the men working in the pit at the time were all supplied with safety-lamps—the "hewers" with Stephenson's, and the "hurriers" with Davy's. Upon this occasion, the whole of Stephenson's lamps over a space of five hundred yards were extinguished almost instantaneously, whereas the Davy lamps became red-hot, producing the effect I have just mentioned. Had a strong current of air been blowing through the gallery at the time, an explosion would have probably taken place.

Some years ago I had a little experience of being in a *gas explosion*. A scientific friend of mine, who had made

some successful experiments in burning oxygen and hydrogen mixed in the same bag, brought his apparatus to my house; but, from some defect in the "Hemmings" jet used, a severe explosion took place.

For a few minutes I was so stunned that I scarcely knew what had happened. At last, staggering out of the room, I called loudly to my servant, "Come and help me, William! I am killed!" although the strength of my lungs proved that a good deal of life was left in me.

On getting into the light—for the explosion had left us in total darkness—I found that my face was much cut about; my shirt-studs had received a blow as with a hammer, and had slightly wounded my chest; the keys in my pocket had wounded my thigh; and my clothes were much torn. When I had recovered a little I told those surrounding me to go and look for my friend—fearing he was really killed—when he came into the room. I was at first quite shocked to see the dreadful state he was in, his clothes being actually torn to ribands; for having had the bag of mixed gases under his arm, the force of the explosion seemed to have rushed up his coat-sleeve. Fortunately, however, he was even less hurt than myself.

When able to go and look at the room, I found it a complete wreck. Every pane of glass was smashed, as were the pictures; the chandelier was broken, and the doors wrenched off their hinges; the dust lay thick upon everything, and the table had received so severe and singular a blow that all the screws fastening on the top had started out without breaking the wood-work.

I had promised to give a scientific lecture a few days afterwards to add to the funds of a charity, and not liking to disappoint the people, patched myself up the best I could, putting on a pair of green spectacles to hide my damaged eyes. My readers, therefore, may imagine the odd figure I

must have presented on that occasion, and I dare say it not a little amused some of my auditors.

There were only a few gallons of mixed gas in the bag which caused all this damage. You can, therefore, form some idea of what the result must be in a mine when thousands of gallons are suddenly exploded.

I have dwelt upon the merits of the safety-lamps intentionally, because I wish that Stephenson's may be fully appreciated.

Fig. 38.—The Fire-Damp Indicator.

There is another invention now before the world which I should like to notice; it is called a "Gas Indicator," and was invented by Mr. G. F. Ansell, and described by Dr. Jabez Hogg at the meeting of the British Medical Association in 1880. The construction of this instrument, of which I give a drawing (Fig. 38), is founded upon the law of the diffusion of gases, the velocity of which is inversely proportional to the square roots of their densities. Thus four volumes of hydrogen will pass through a porous *diaphragm* in the same time as one volume of oxygen, which

is sixteen times heavier. The passage of the lighter gas operates upon some delicate mechanical appliances and moves the index. The instrument can detect the presence of light carburetted-hydrogen gas in mines; and, as the Indicator can be made as small as a good-sized watch, the under-viewer of a mine could readily take it into the various galleries before the men enter them, which would enable him to tell the amount of gas present, and thereby prevent many disasters.*

There are other dangers which the miners have to endure besides those arising from marsh gas. For sometimes water bursts into the mine, and then the poor men are often drowned, or they get shut up in galleries and are starved to death before they can be rescued. Many a sad story of this kind, as well as many acts of bravery and endurance, could be told; but I am afraid this chapter has already exceeded the proper length. I must notice, however, that frequently an explosion sets fire to the mine, and then the loss of property as well as of life is sometimes immense, for it is very difficult to put out such a fire with so much inflammable material on all sides. In reference to this there is another good story of Stephenson which I always love to tell. One day a workman ran into George's cottage with the startling information that the deepest main colliery was on fire. He immediately hastened to the pit's head, whither the women and children were hurrying, with wildness and terror depicted on every face; every one seemed too frightened to know what to do or where to go. George took no time to consider, but in a commanding voice ordered the engine-man to lower him down the shaft; immediately stepping into the "corve," he began to descend. Fear, as I have said before, had no place in his manly heart; and deeper and deeper as the "corve" went down, nearer and nearer was he to extreme peril or, it might be, death.

* Mr. Frederic Newton, optician, No. 2, Fleet Street, will be pleased to give any further information in reference to this instrument.

And yet he quailed not; he was facing danger in order to save lives and property; and if he failed, then his death would be sweetened with the consciousness of having done his duty. On reaching the bottom he leaped from the "corve" into the midst of a number of men who were huddled together, paralysed by the catastrophe, and cried out, "Are there six brave men here who have courage to follow me? if so, come, and we will put the fire out." The Killingworth pitmen had the most perfect confidence in their engine-wright, and they readily volunteered to follow him. Silence succeeded the frantic tumult of the previous minute, and the men set to work with a will.

In every mine bricks and mortar and tools enough are at hand, and by Stephenson's direction they were carried towards the part where the fire was raging. On they all went through the suffocating smoke and vapour until they came to the main gallery, where the conflagration was fast extending itself; and then they all set to work with such earnestness that in a very short time a wall was built up which excluded the atmospheric air and soon extinguished the fire. The people were saved from death, and the mine preserved.

I like to dwell upon the noble deeds of this self-made man—of this Nature's gentleman; and I honour Dr. Smiles for writing his history so graphically and so well, which every one should read, for if ever there was a model man it was George Stephenson.

I trust this addendum to my chapter on the ancient flora will not be unacceptable to my readers, for I think that when we are enjoying our social firesides we should not only recall the ages long gone by when the coal was formed, but also the dangers and hardships endured by those who obtain for us this great luxury.

In the time of Moses coal was not known; and, there-

fore, when he saw this third and beautiful vision, he could have no idea how much good would result to mankind from the luxuriant and universal verdure. Those magnificent Sigillariæ, those tall Conifers, those lovely waving Ferns, were not created in vain, but for purposes of future utility, and to call forth admiration of the great Creator who thus arranged all things in infinite wisdom.

CHAPTER VI.

"And God made two great Lights."

This must have been a glorious vision for Moses; and if David later on, when reclining upon the grassy meads of Palestine, during a bright starlight night, exclaimed with rapture, "The heavens declare the glory of God," what ecstasy must the holy prophet have experienced when he saw the Sun for the first time during those wondrous visions pouring down its direct rays upon the Earth, and lighting it up with a beauty to this period unknown!

The mountains would stand out with well-defined sharpness, their tops having a bright blue sky for a background; their slopes would more or less be covered with verdure, and down their sides would roll the streams which, uniting, swelled into rivers. The waters, falling from rock to rock in ten thousand sparkling cascades, would glitter in the sunshine; trees of a different species to those of the last vision would be seen in all directions; although in the shady valleys the fern tribes, herbaceous and arborescent, would still thrive and add beauty to the landscape. Doubtless it was a lovely picture for him to look upon; and whilst he gazed with admiration, he saw the Sun set in the western horizon, as "the Lesser Light" rose in the eastern and threw a halo of gentle refulgence over the same landscape; then thousands of glittering Stars shone forth in the canopy of heaven, "*and the evening and the morning were the fourth day.*"

I have now to show you that these events, as related by Moses, also took place in their proper order, and that Science teaches us that at this period the Sun and the Moon were appointed to be "*for Signs and for Seasons, and for Days and Years.*"

If my readers will turn to page 142, they will see what I have said about different meanings to the same word. Now the translators of our Bible evidently knew that עָשָׂה (*'āsāh*) meant *appointed* as well as *made*, for we find that in the 104th Psalm, 19th verse, they have so translated it: "He *appointed* the Moon for seasons, and the Sun knoweth his going down."

In 1 Kings xii. 31, we read, "He *made* priests of the lowest of the people;" and in 1 Sam. xii. 6, "It is the Lord that *advanced* Moses and Aaron, and that brought your fathers up out of the land of Egypt." The word עָשָׂה (*'āsāh*), used in both those cases in the Hebrew text, evidently means *appointed*.

This fact I must earnestly impress upon my readers, for it helps to clear up a very great difficulty which has given many good men much concern, and the sceptic has made use of it to scoff at the very idea of so great an error coming from a professedly inspired writer.

Let me call your attention to the fact that in the whole chapter the word "created" occurs only on three occasions, but in the twenty-seventh verse, when the creation of man is related, it is repeated *three* times over.

This word בָּרָא (*bārā*), translated "created," really means to be produced out of nothing, or a passage from inert matter to animate life, which no force, process, or energy known to man could accomplish; it is a very different word from עָשָׂה (*'āsāh*), translated "made," which I have just explained. I have shown you before that both the Sun and Moon must have been created contemporaneously with the

Earth, but that during the early ages of the world much of their light was hidden from our globe by the dense vapours which surrounded it; that, up to the time now under consideration, a similar climate existed all over the Earth; and that, therefore, there were no seasons properly so called until after the Carboniferous period. When, however, the Sun blazed forth in all his glory, seasons commenced, as both the fauna and flora testify.* In the Permian system the profuse vegetation of the Carboniferous no longer existed; but the fossil remains of plants show a great increase of a ligneous or woody tissue, which could only have been produced by the presence of unclouded sunlight. Most of the trees I described in the last chapter were of a soft and pulpy nature, with no season-rings, for huge trunks several feet in diameter are found in the coal compressed and flattened when they lie in a horizontal or inclining position; season-rings, however, are found in the flora of the Trias and Secondary strata.

The animals from the Silurian up to the end of the Carboniferous era in widely-separated districts all over the globe correspond with each other, although the mineralogical characters of the deposits in which they have been buried are in many instances very dissimilar; whereas those of the Trias, Oolite, and Chalk are very dissimilar in form and appearance when found in localities distant from one another, and the organisms of the Tertiaries in distant countries differ as much from each other as the animals and plants of our own era.

From these facts it may be inferred that previous to the Triassic age there was a uniformity of climate; this uniformity now ceased, and a diversity of climate, of which the Sun was the principal cause, commenced, and has ever since existed throughout the world; consequently, the Sun

* There was probably also a continuous twilight from the dense and vaporous condition of the atmosphere, and here again Science and the Bible harmonise, for the Sun was not appointed "*to rule over the day and over the night, and to divide the light from darkness*" until after this period.

became at this era not only the visible sign for distinguishing days and years, but also the efficient cause of seasons.

Having said thus much in reference to the evidence of the appointment of the Sun and Moon for signs and for seasons coming in its right order in the wonderful account of creation, I will now give a short description of some of these heavenly bodies, and will commence with

THE GREATER LIGHT.

The distance of the Sun from us can only at present be arrived at with proximate accuracy; yet we may feel certain that the estimates made by astronomers are very near the truth. One important method has been by watching the transits of Venus, which take place at periods varying between 8 years, 121½ years, 8 years, and 105½ years. The last transit but one took place on December 8, 1874, and the last on December 6, 1882; the next one will not happen until June 7th, 2004.

In 1769 George III. sent an expedition, under the command of Captain Cook, to watch the transit at Otaheite, in the South Seas; and the chief Continental Powers followed his example by sending astronomers to the most advantageous parts of the globe, as far apart as possible, some going to Lapland, some to Pekin, others to California, &c.

Various determinations were afterwards made of the results deducible from all these observations, but ultimately it was generally allowed that that obtained by Encke was correct, which gave the horizontal parallax as 8″·58, and the mean distance of the Sun from the Earth about 95,000,000 miles.

For some years past several things have led astronomers to believe that this was a little too much, and therefore great interest was manifested amongst them in 1874, when many expeditions were planned, as well as valuable instru-

ments contrived and careful preliminary calculations and preparations made, to insure the utmost amount of success. Parliament voted some £40,000 for the undertaking. Eminent men of all nations took up their stations at the most desirable spots upon the surface of the Earth, and as the day approached the excitement seemed to culminate. I was at a meeting of our Society when Sir G. Airy, then Astronomer Royal,* read one telegram after another to the enthusiastic meeting. Space seemed annihilated; we appeared literally to be talking with men in Egypt and Japan, in Australia and Siberia, in Siam and the Sandwich Islands. My esteemed friend, His Excellency Prince Malcom Khan, the Persian Ambassador, who was then reading English Literature with me, had accompanied me, and was intensely interested.

The press also entered heartily into the spirit of the day; reporters were copying down the words of our learned chief with nimble fingers, and their journals the next morning devoted columns to the absorbing subject. Well, the most minute particulars of these observations had to be all collected, and based on them were commenced a series of elaborate calculations, which continued for many months, and were composed of millions of figures and symbols. At last the grand result was obtained, and the mean distance of the Sun from the Earth was stated to be a little more than 93,000,000 miles. This will be confirmed or corrected when all the calculations are completed in reference to the transit of the 6th of December, 1882, in which all astronomers took the deepest interest; for who of us will be alive at the next transit in 2004?

There are other methods of ascertaining the distance of the Sun from the Earth, which confirm these calculations. One of these I will mention. Dr. David Gill, Her Majesty's

* Sir George Airy, after worthily filling this distinguished office for very nearly forty-six years, resigned on the 15th of August, 1881, and was *succeeded* by Mr. Christie, son of the late Prof. Christie, of Woolwich *Academy*.

Astronomer at the Cape of Good Hope, has published his determination of the Solar parallax, made from observations of the planet Mars in 1877. The result of his computations makes the horizontal parallax 8″·78; this will give us the mean distance of the Sun from the Earth as 93,080,000 miles.

Much, very much, has been written lately about the actual and most probable value of this important element in the Solar System, on which nearly all other distances and dimensions depend. Professor Young, of the College of New Jersey, in a most able and interesting book he has just published on "The Sun," says (p. 43): "Collecting all the evidence at present attainable, it would seem that the Solar parallax cannot differ much from 8″·80, though it may be as much as 0″·02 greater or smaller; this would correspond to a distance of 92,885,000 miles." On the whole we may safely say that the true distance differs but little from 93,000,000 miles.

Having found the distance, the size of the Sun is easily ascertained. According to this last estimate, the diameter is about 866,000 miles, the circumference 2,720,000 miles, and the area of the surface 2,356,000,000,000 (upwards of two billions) of square miles. These large numbers cannot be well grasped without some comparison with smaller ones. If, then, the Sun occupied the place of the Earth, it would fill the whole orbit of the Moon, and extend about two hundred thousand miles on all sides beyond it; for the diameter of the *orbit* of the Moon is about 480,000 miles, or a little more than half the diameter of the Sun.

The Sun's surface is about 11,940 times that of the Earth; its volume is equal to a million and a quarter Earths, or sixty-five millions of Moons. And if all the planets and satellites in the Solar System were massed together into one lump, 500 such monster lumps would only amount to the volume of the Sun. Is it not, then, as to size, a magnificent world?

The Spots on the Sun.

Every one has heard of these spots, but perhaps only a few are aware how much interesting and important information their study has afforded; and as they especially illustrate the subject of this chapter, I will give their history.

In 1611, Fabricius, whilst observing the Sun just after sunrise with a telescope of inconsiderable power, noticed upon its disc a black spot, which he supposed to be a terrestrial cloud. He found, however, that the object, whatever it was, belonged to the Sun. As the Sun rose he had to discontinue his observations, for he possessed no means of mitigating the brilliancy of the Sun's light. In telling his story in a work he published at Wittenberg, he says :—

"My father and I passed the rest of the day and the whole night in great impatience, trying to think what this spot might be. 'If it be in the Sun,' I said, 'we shall no doubt see it again; if not, its motion will have carried it from the Sun's disc, and we shall be unable to see it.' On the next morning, however, to my delight, I saw the spot again. But it was not in the same place—a peculiarity which increased our perplexity.

"We determined to obtain an image of the Sun on a sheet of paper by permitting its rays to pass through a small hole in a darkened chamber; and in this way we again saw the spot quite clearly in the form of an elongated cloud. For three days we were prevented by bad weather from continuing our observations; but at the end of that period we again saw the spot, which had crossed obliquely towards the western side of the Sun's disc. Another smaller one had made its appearance near the eastern edge, and in a few days this second spot reached the middle of the disc. Lastly, a third spot appeared. The three spots vanished in the order of their appearance. I was hopeful that they would be seen again, but was yet perplexed by doubts and fears; however, ten days afterwards the first re-appeared on the eastern side of the disc. I knew then that it had revolved completely round the Sun, and since then I have convinced myself that this was really the case."

Fabricius thus studied the import of his observations, and at last concluded that the spots were upon the Sun itself.

"'We invite,' says he, 'the students of Science to profit by our description; they will doubtless conclude that the Sun has a motion of rotation, as Jordanus Bruno has asserted, and more lately Kepler. Indeed, I do not know what we could make of these spots on any other supposition.'"

Fabricius was not the only one who saw these spots; for about the same time, and quite independently, that brave pioneer of astronomical science, Galileo, when turning his primitive telescope upon the Sun, noted them upon its surface, and they puzzled him much afterwards. He and Scheiner discussed this subject together, but they only agreed upon what they were not. As to what they *were* they differed greatly. Galileo at one time declared for clouds in an invisible atmosphere of the Sun; whilst Scheiner contended for a density and opacity equal to that of the Moon—in fact, for planets separated from the Sun's surface, and revolving round him, like Mercury and Venus.

A long series of observations of sun-spots now began, and many hypotheses of more or less ingenuity were put forward to account for the phenomena which they present. For years Galileo pursued the study of these spots, until, from viewing the Sun so often without the dark glasses now commonly employed, this dear old philosopher, in 1637, utterly lost his eye-sight. He was then seventy-three years of age, and it would be difficult for us to conceive the enormous trial it must have been to him to be thus entirely shut off from his beloved occupation. He lived, however, to the good old age of seventy-eight, and died on January 8th, 1642. I can strongly recommend to my readers an excellent life of this great man, principally compiled from his correspondence and that of his eldest daughter.*

* Macmillan and Co.

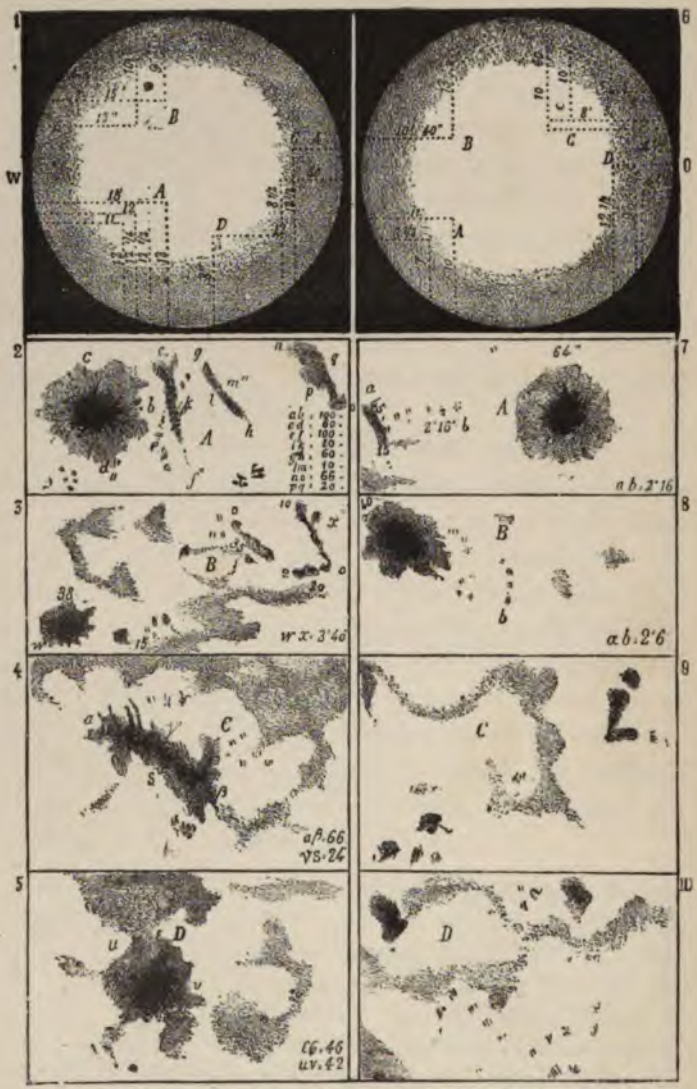
For a century and a half but little more was learnt respecting these spots. In 1769, however, there was a large one visible upon the Sun; and Dr. Wilson, of Glasgow, after observing it very carefully, pronounced it to be a cavity; and, though Lalande and other astronomers combated the cavernous theory, it maintained its ground, and does so still.

Dr. Wilson also showed that the surface of the Sun was of a cloudy nature, which modern discoveries prove to be correct, for a change of form on the surface is constantly going on, which would be an impossibility on either a liquid or a solid surface, such as land or sea, but quite possible on a surface of cloud or gas. Spectrum analysis has now quite confirmed the gaseous theory.

Sir William Herschel studied these spots with great perseverance, and wrote largely about them; also his son, Sir John, while residing at the Cape of Good Hope in the year 1837, made many valuable observations; but the most diligent observer was Herr Schwabe, who commenced in 1826 to watch them, and this he did daily for thirty-one years, and demonstrated that they increase and diminish in frequency and size in a period of about ten or eleven years. In 1857 he was awarded the gold medal of the Royal Astronomical Society, and the President, Mr. Johnson, at that time Radcliffe Observer at Oxford, acknowledged the importance of his researches in these words:—

"What the Council wish most emphatically to express is their admiration of the indomitable zeal and untiring energy which Herr Schwabe has displayed in bringing that research to a successful issue. Twelve years he spent to satisfy himself; six more years to satisfy astronomers; and still thirteen more to convince mankind. For thirty years never has the Sun exhibited his disc above the horizon of Dessau without being confronted by Schwabe's imperturbable telescope; and that appears to have happened on an average about 300 days a year. So that supposing *he observed* but once a day, he has made 9,000 observa-

May 24. June 21.



IX.—Solar Spots observed by Pastorff, 1828.

(*A fac-simile from his manuscript work.*)

tions, in the course of which he has discovered 4,700 groups. This is, I believe, an instance of devoted persistence unsurpassed in the annals of astronomy. The energy of one man has revealed a phenomenon which had eluded even the suspicion of astronomers for 200 years."

After this thirty-one years' labour he continued his observations as pertinaciously as ever, until 1870—forty-four years.

In connection with these spots of the Sun I remember an interesting little episode. I was present at a meeting of our Royal Astronomical Society in 1859, when Sir John Herschel handed to the President three manuscript volumes containing the whole of the daily observations of Pastorff from 1819 to 1833, which had been presented to him on condition that he would not part with them as long as he lived. "I cannot, therefore," he said, "give them to the Society just now, but I will lend them to your librarian that the Fellows may refer to them, and when I am gone then the Society may retain them as my legacy." Sir John died on the 11th of May, 1871, at the good old age of seventy-nine.

One can quite understand that Sir John would be entrusted with the custody of such treasures, for he had given much time and careful study to these phenomena, and though his deductions are not all now admitted in their entirety, the facts which he collected were invaluable.

By the kindness of Messrs. Crosby Lockwood and Co., I am able to give my readers a copy of two of the pages of these valuable volumes, May 24 and June 21 (Plate IX.), which, with others, are in Dunkin's edition of Lardner's "Handbook of Astronomy," one of the most accurate and popularly-written works on the subject. The following information in reference to these Pastorff's spots is from this excellent book.

The dimensions of the principal spot of the group A, seen on May 24th, 1828, were stupendous. Measured in a plane at right angles to the visual line, the length was 44,300

miles, and the breadth 26,580. The superficial dimensions of the several groups of spots observed on the Sun on the 24th of May at 10 A.M., including the shelving sides, were calculated to be as follows :—

	Square Geog. Miles.
Group A, principal spot ...	928,000,000
Ditto, smaller spots	736,000,000
Group B	296,000,000
Group C	232,000,000
Group D	304,000,000
	2,496,000,000

To fully comprehend the size of these big holes, amounting in area to more than two thousand millions of geographical square miles, is indeed a very difficult task.

Of the great size of some of the spots, Proctor gives much highly interesting information, and says that the immense dimensions of these spots well deserve thoughtful consideration. When we remember that the least spot which could be perceived with the most powerful telescope must have an area of at least 50,000 square miles, it will be understood how enormous those spots must be which are sometimes distinctly visible to the unaided eye. Fig. 39 is a representation of some unusually large ones seen by Mr. Proctor on September 25th, 1870, showing their appearance when seen through one of his telescopes.

In the month of June, 1843, a spot was visible, which, according to Schwabe's measurements, had a length of no less than 74,816 miles.

On March 15th, 1858, observers of the great Solar eclipse had an opportunity of witnessing the passage of the Moon over a spot which had a breadth of 107,520 miles. It was in the same year that the largest spot of any on record was visible upon the Solar disc. It had a breadth of more *than 143,500 miles*; so that across it no less than eighteen

globes as large as our Earth might have been placed side by side. This enormous cavity was such that, at a moderate computation, 100 globes as large as our Earth would barely have sufficed to fill it to the level of the Solar photosphere.

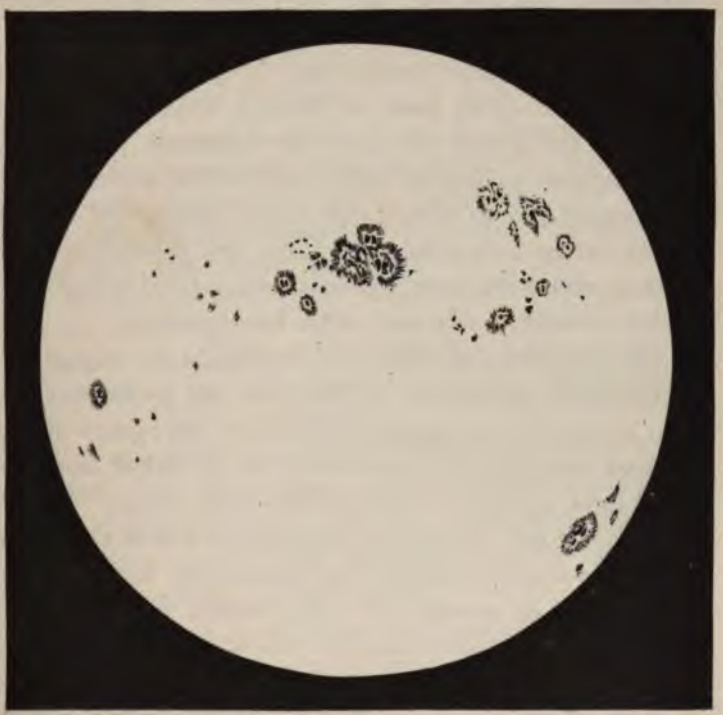


Fig. 39.—The Sun as seen by Mr. Proctor on September 25th, 1870.

One of the most remarkable results following upon Schwabe's noble and patient observations was the recognition of an association between the Sun-spots and magnetic disturbances on the Earth, which are at once indicated by the abnormal oscillation of the magnetic needle. Lamont, of Munich, was the first to announce that these magnetic disturbances attain a maximum of variation about every ten

years. This was in 1850. Two years later, quite independently of one another, General Sabine and Professors Wolf and Gautier noted the coincidence that when the Sun was covered with the maximum number of spots, the magnetic disturbance was greatest; and when there were the fewest spots on its surface, the disturbance was at its minimum.

Wolf subsequently proved that the period of magnetic disturbance is 11·11 years in length, which he had assigned as the correct value of the Solar-spot period. A correspondence so strange might well excite grave doubts. Coincidences have so often misled men of science, and it is so certain in the very nature of things that misleading coincidences must occur, that physicists were justified in requiring further evidence; and it came when least expected.

On September 1st, 1859, Mr. Carrington was engaged in his customary observations of the forms and positions of the Solar spots, and was especially noticing a large group in the northern hemisphere, when suddenly two patches of intensely bright light broke out in the middle of the group. At first he thought a ray of light had penetrated a hole in the screen attached to the object-glass; but causing the image of the Sun to move, by turning the right-ascension handle, he saw that this intensely illuminated spot was on the Sun itself.

Noting the time by his chronometer, and seeing the outbreak to be rapidly on the increase, he ran hastily to call some one to witness the exhibition. On returning in less than sixty seconds, he was mortified to find that it was already changed and enfeebled, and shortly afterwards all trace of it was gone. During the five minutes which this sudden conflagration lasted, the two bright spots traversed a space of 35,000 miles.

It was Mr. Carrington's opinion that the phenomenon took place at a considerable elevation above the surface of the Sun, *or he did not find* any change in the appearance of the Solar

spots he was before observing. As he witnessed all this in an image of the Sun thrown upon a screen, some objections might have been raised as to the reality of the phenomenon; but most fortunately another gentleman, Mr. Hodgson, was watching the Sun at the same moment in another observatory, and wrote down his account of the same occurrence before he knew anything of Mr. Carrington's observation. His statement runs as follows :—

"While observing a group of spots on September the 1st, I was suddenly surprised at the appearance of a very brilliant star of light, much brighter than the Sun's surface, most dazzling to the protected eye, illuminating the upper edges of the adjacent spots and streaks—not unlike, in effect, the edging of the clouds at sunset. The rays extended in all directions, and the centre might be compared to the dazzling brilliancy of the bright star Alpha Lyræ when seen in a large telescope with low power. It lasted for some five minutes, and disappeared instantaneously about 11.25 a.m."

I must here acknowledge my indebtedness to Mr. Proctor for much useful information, and beg to express most strongly the gratitude we all owe to him for rendering the science of astronomy so popular and interesting. Every one of his works will well repay careful reading.

It is probable, says Proctor, that whereas two spots were seen by Mr. Carrington, who observed the Solar image projected upon a screen, these were blended, owing to their extreme brilliancy, into the semblance of a single spot when observed in the telescope itself by Mr. Hodgson. And now comes the intimate magnetic relation between the Sun and the Earth. At the moment when these Solar phenomena occurred, the magnetic instruments at Kew exhibited those signs that indicate the occurrence of a magnetic storm raging over all the Earth.

Sir John Herschel describes the events of that particular day and the following one in these words :—

"By degrees accounts began to pour in of great auroras seen on the nights of those days, not only in these latitudes, but at Rome, in the West Indies, in the tropics within 18° of the equator (where they hardly ever appear)—nay, what is still more striking, in South America and in Australia, where at Melbourne, on the night of September the 2nd, the greatest aurora ever seen there made its appearance. These auroras were accompanied with unusually great electro-magnetic disturbances in every part of the world. In many places the telegraph wires struck work. They had too many private messages of their own to convey. At Washington and Philadelphia, in America, the telegraphic signalmen received severe electric shocks. At a station in Norway the telegraphic apparatus was set fire to; and at Boston, in North America, a flame of fire followed the pen of Bain's electric telegraph (which writes down the message upon chemically-prepared paper)."

I should like to speak of the effect of the planets when in certain positions in reference to these spots, but fear that doing so would greatly extend this chapter.

The variable and irregular prevalence of the spots on the surface of the Sun is worthy of particular notice. Sometimes the disc will be completely divested of them, and will continue so for weeks or months; sometimes they will spread over certain parts of it in profusion; sometimes the spots will be small but numerous, and sometimes, as I have before mentioned, individual spots will appear of vast extent; at other times they will be manifested in groups, the penumbræ, or fringes, being in contact.

The duration of each spot is also subject to great and irregular variation. A spot has appeared and vanished in less than twenty-four hours, while some have maintained their appearance and position for nine or ten weeks, or during nearly three complete revolutions of the Sun upon its axis. I may also state that a large spot has sometimes been observed *suddenly to crumble* into a great number of small ones.

I have stated that the rotation of the Sun upon its axis was very early conjectured by Fabricius, by watching the progress of a particular spot; and Galileo made many careful observations with this end in view, and was, even with his imperfect instruments, so near the truth that he fixed the period at 26 or 27 days. Laugier put it at 25 days, 8 hours, 10 minutes; but Carrington, after taking most carefully into consideration the motion of the spots themselves, calculated the period of this rotation to be 25 days, 9 hours, 7 minutes.

I have thus given a rather more lengthy account of these spots than I intended; but think my readers will be as deeply interested as myself in the marvellous proofs Carrington and others have given of this Greater Light being appointed as a mighty ruler of the seasons. For we learn from such facts that these electric storms on the Sun not only affect widely-extended regions of the Earth, but that in some well-authenticated instances the magnetic vibrations have thrilled in one moment the whole frame of the Earth, and probably the whole Solar System, even to the far-distant Neptune.

I must not forget to notice that great waves or elevations are often seen upon the surface of the Sun, which, on account of their extra brightness, are called *faculæ*, or torches. These are hundreds of miles in height and thousands of miles in length. Herschel saw one 74,000 miles long. Try to imagine a mighty billow of fire towering upwards for hundreds of miles, and long enough to thrice encircle the Earth!

With regard to the heat, light, and composition of the Sun, I have told you much in the second chapter; but I will just repeat that it has been calculated that from every square yard of the Sun there flashes into space an amount of heat equal to that of a blast-furnace consuming a ton of coals every ten minutes, which would be equal to three

hundred trillions of tons for the whole surface—about $\frac{1}{2\,0}$th the weight of the Earth.

In reference to this heat, the calculation of Sir John Herschel is interesting; he says that if the direct heat of the Sun were received upon a surface capable of absorbing and retaining that heat, a block of ice an inch in thickness would be melted in 2 hours, 13 minutes; therefore, upon a square mile, no less than 26,000 tons of ice would be melted per hour; and this amount of heat must be multiplied fifty millions of times to correspond to the heat actually received by the Earth's globe during a single hour. Expressing this result in a somewhat different method, he states again that if the Sun's heat received by the Earth in the course of a year were distributed uniformly, it would be sufficient to liquefy a coating of ice all over the Earth's surface 100 feet in thickness, or to heat a universal ocean of fresh water sixty-six miles deep from the temperature of melting ice to the boiling-point. Yet this enormous annual supply of heat is but an excessively small fraction of the Sun's total heat, being only the $\frac{1}{2,136,000,000}$th part of the heat which it actually radiates into space in the course of a year.

And as to its light, very large numbers would also have to be employed to express its amount; but perhaps one simple comparison will make this easily intelligible. If half a million wax lights could be placed close together, their united illumination at a distance of ten feet would not exceed that of daylight on an unclouded summer's day.

Such, then, is the Greater Light which at this period was appointed for signs and for seasons, and now by its vivifying action calls forth vegetable life of infinite variety and beauty, deriving nourishment from inorganic matter, and becoming in its turn the support of animals and man. It distils the waters of the sea and draws them up to heaven, *whence they are again* poured down upon the Earth, and

truly, in the words of Scripture, "drop fatness." It gives rise to differences of temperature, resulting in the generation of winds, which play an important part in purifying the air by carrying away noxious gases, and by wafting the fertilising clouds to regions distant from the sea, where they are generated. It produces the various chemical changes which give rise to a series of compositions and decompositions, and diversify the face of the Earth with fresh beauties and fresh combinations.

So much of heat, light, and life emanate from this mighty world that it is indeed a glorious emblem of its Divine Creator; and the contemplation of its majesty and power cannot fail to elevate the mind and to fill it with the profoundest adoration of Him who said, "*Let there be light,*" *and there was light.*

The Lesser Light.

Who is there, anywhere upon this Earth, when looking up towards heaven, and observing the crescent-shaped Moon in the star-bespangled sky, that has not been filled with admiration of the soft and soothing beauty of the scene? Even the most uneducated are unconsciously impressed with it, and a tiny child will clap its little hands together and exclaim, "How lovely, mamma!" They do not know what the philosopher does of the ruler of the night, and yet they understand enough to see that the Hand that made it is Divine.

As I have before noticed that the Earth up to this fourth period was surrounded with aqueous and other vapours which hid from it the Sun, so doubtless they also concealed the Moon, which in those early ages of the world must have been in a very different condition to its present state. I have no doubt in my own mind that it was formed in a similar manner to the Sun and the Earth, by the gradual accretion

of nebulous and meteoric matter; which matter, coming together with great force, engendered intense heat, so that for a length of time the Moon was a miniature Sun. In the course of ages, however, it cooled down, and was appointed to fulfil its present important duties as a satellite to our Earth. From its proximity to us, astronomers, since the invention of the telescope, have been able to learn much of its constitution, and indeed to map out its surface with as much accuracy as geographers have the Earth. Turning upon the full Moon a telescope of only a low power, the dark and light patches are resolved into a series of mountains and plains. These mountains, however, are in many respects very different from ours; for the most part they seem to be extinct volcanoes, but their great size and peculiar shape at once strike the observer who would try to discover the cause of such a remarkable configuration.

The description I gave of the gradual cooling of the Earth will apply equally to the Moon. The exterior surface first became solid by radiating its heat into space, while the interior retained its hot and molten condition. An outer solid shell would be thus formed, which would continue to contract as it still further cooled. Gradually this cooling process would extend inwardly; but at first, instead of this producing contraction, it would give rise to an expansion, which would crack and dislocate the outer shell.

It may seem strange that I should talk in one place of a cooling body contracting and in another of its expanding, but I will explain this by one or two simple illustrations. When a kettle quite full of water is put upon the fire, we find the water expands, and, forcing up the lid, runs over; if it be allowed still to remain on the fire till it boils, the water pours out of the spout with much force, until a certain quantity is got rid of. If we now take the kettle off the fire and look *into it, we shall see* that it is still quite full, notwithstanding

that so much water has escaped; this proves most clearly that hot water occupies more space than cold.

Now suppose it should be winter time, and there be a sharp frost; if we take our kettle into the open air, we shall see some remarkable results. First, on cooling, the water will gradually diminish in bulk until it sinks to the temperature of 39°, when, strange to say, it will commence to expand again; and by the time it gets below 32°, and ice is formed on its surface, the water will have risen almost to the lid. We will now stop up the spout and solder down the lid, and leave the kettle in the open air; if the thermometer should sink during the night to 20° below freezing, what should we find in the morning? Why, the kettle burst all to pieces, and the solid mass of ice exposed on every side!

Thus, then, it is clear that water in a solid form occupies more space than when fluid; and this is just what happens in the case of melted metals and molten rocks, as Nasmyth has so well described in the opening chapter of his excellent work on the Moon, in which he says that he made many experiments with melted substances, and always found that solid portions floated in a molten mass of the same mineral—proving that it was denser when melted. After, however, such substances had assumed the solid form, they would expand with heat and contract with cold in well-known ratios.

Now, applying these experiments to the cooling down of the Moon, at first the intense heat would keep the whole mass in a fluid or molten condition; but when by radiation the outer surface cooled, it would first expand and then contract, forming a solid crust around the central fused mass. In course of time this fluid interior would also cool, and as it did so would, as I have shown, expand, and cause great convulsions of the newly-formed crust. This would go on when those solidifying portions became also part of the crust; and thus cracks, fissures, and upheavals would take place.

Nasmyth says that when the molten substratum had burst its confines, ejected its superfluous matter, and produced the resulting volcanic features, it would, after final solidification, resume the normal process of contraction upon cooling, and so retreat or shrink away from the external shell. Let us now consider what would be the result of this. Evidently the external shell or crust would become relatively too large to remain at all points in close contact with the subjacent matter. The consequence of a too large solid shell having to accommodate itself to a shrunken body underneath it would be, that the skin, so to term the outer stratum of solid matter, would become shrivelled up into alternate ridges and depressions, or wrinkles.

In the attempt to crush down and follow the contracting substratum, it would have to displace the superabundant or superfluous material of its former larger surface by thrusting it into undulating ridges, or broken elevated overlappings of the outer crust, or ridges capped by more or less fluid molten matter extruded from beneath.

Any one looking at the Moon with the naked eye sees marked differences of illumination, and through all ages they have been fancifully thought to resemble figures of men and animals; and even philosophers not many years ago believed that it possessed surface irregularities like those that diversify the face of the Earth, and therefore they inferred that seas and continents alternated on the lunar globe. So much was this the general belief that large plains on the Moon's surface received the name of seas, such as Mare Imbrium, Mare Nubium, Mare Tranquillitatis; and these names are still retained, to avoid the confusion of change, though there are neither clouds nor showers there.

Doubtless every one who has observed the various phases of the Moon has noticed that the markings on its face undergo no perceptible change; and, therefore, the same side of its

sphere is always towards us. This could only happen by its having an axial rotation equal in period to its orbital revolution, which is 27d. 7h. 43m. 11s.; but as the Moon, whilst revolving round the Earth, is also accompanying it round the Sun, the solar day upon the Moon is a little longer—viz., 29d. 12h. 44m. 2⅞s.

In consequence of a libratory motion, we do, however, sometimes see a small portion of the other hemisphere; and this was even discovered by Galileo, with his imperfect telescopes.

So large are the inequalities on the surface of the Moon, that even with a glass of a very moderate power the principal features can be readily seen. But our highest powers cannot give us the exact details of its landscapes; for with a power of 400 diameters an object 450 feet long would only appear as a point, although one square mile seen through such a power would be magnified to the space of 160,000 square miles as seen with the naked eye. This at present, Nasmyth says, is the highest practical power we could use on one of our largest telescopes; therefore details smaller than St. Paul's are quite beyond our present reach. And yet we know much, very much, of the grand objects on the Moon's surface; but before I attempt to describe them I will notice its

Form, Size, Density, and Mean Distance.

As to its form, from careful measurement of its two diameters, it seems to be a perfect sphere, or nearly so, and not flat at the poles, like the Earth and the rest of the planets. Its size, as ascertained by very accurate calculations, is as follows:—The diameter is 2,160 miles, the area of its entire surface 14,657,000 square miles, and its solid contents 5,277,000,000 cubic miles. Nevertheless it would require forty-nine such bodies to equal the volume of the Earth, and 65,000,000 (sixty-five millions) of Moons would be necessary to make up the volume of the Sun.

Its density being about three-fifths that of the Earth, if weighed together, eighty Moons would only balance the Earth. The force of gravity upon the Moon is one-sixth that upon the Earth; therefore one pound here would only weigh 2⅔ ounces on the surface of the Moon.

It follows from this that any force, such as muscular exertion, or the energy of chemical, plutonic, or explosive forces, would be six times more effective upon the Moon than upon the Earth. A man who could jump five feet from the Earth could with the same muscular effort jump over a perpendicular rock thirty feet high on the Moon; and, therefore, the explosive energy of a volcano which would project a body five miles upon the Earth, would hurl it thirty miles upon the Moon. This will enable us to understand one reason why the craters of the mountains of the Moon are so much wider than those upon the Earth.

The mean distance of the Moon from us is 237,300 miles; but I fear I shall have wearied you with so many figures, important though they be, and pass on therefore to a more interesting subject.

The Mountains of the Moon.

Perhaps the following little allegory will help my younger readers to understand better the lunar landscape:—

It was a beautifully clear summer's night, and the Moon was at its full, lighting up the Earth with a soft and gentle radiance. I was gazing at it with a friend, and admiring its loveliness, when an aërial being came towards us, and offered to take us to that distant world, and show us all its wonders. We were in raptures, and, consenting at once, were rapidly borne away from the Earth.

After travelling night and day for six months, at the rate of a mile a minute, we arrived at the Moon, and *were set down* upon the top of the outer edge of Tycho's

ring. How strange, how grand was the sight! As we turned towards the interior of the crater, and gazed across it, we could scarcely see the opposite side, 54 miles off. Then looking down we noticed rampart upon rampart, until, at a depth of three miles from where we were standing, a plateau extended for many square miles, from the centre of which a cone, rising about a mile in height, covered up the orifice from which the ashes and scoriæ were hurled to form this mighty rising. Turning round, we saw on all sides similar craters and cones, extending over thousands of square miles, and presenting a landscape perfectly arid, yet sublime.

We had not our camera with us; but down upon the Earth, Mr. Warren De la Rue was taking photographic views of this marvellous landscape; I fear, however, we were too small to be seen in his pictures.

We tried to imagine the grandeur of the scene when these extinct volcanoes, large and small, were all in active ebullition. Whilst occupied with such thoughts, we noticed a series of long bright streaks glittering in the sunlight, and at first supposed they were rivers rolling down from these mountain-heights; but no rippling of the waters could be seen, nor were they dashing in cataracts over the innumerable precipices. Much surprised, we looked again, and found they were broad fissures filled to their edges with white lava—telling the story of that mighty convulsion of the Moon's crust when its last throes cracked it in hundreds of places, the great rents extending from 10 to 1,000 miles in length and about a mile in breadth.

Having looked on with amazement almost amounting to awe, we descended the steep and rugged sides of the crater to commence a journey north-eastward, until we came to another interesting mountain, named after the great astronomer Gassendi. The ring of this is 55 miles

across, but not quite so high, being 9,600 feet from the plateau, in the centre of which are a group of conical mountains, each rising some 7,000 feet. Towards the north of this crater another is seen, 18 miles in width, that has broken through the sides of the larger one, and poured

Tycho.

Fig. 40.—Lunar Landscape in the neighbourhood of the Crater Tycho.

its lava over the plateau. Mound rises above mound, rampart above rampart, and rocks are piled upon rocks. Monster chasms yawn on every side, some of which are a mile wide, 100 miles long, and 10 miles deep. We trembled even to look at these awful chasms from a *neighbouring* height, and turned from them to pursue our

journey farther north until we arrived at Copernicus, the most wonderful and the most magnificent of the Moon's volcanoes.

Although the diameter of its ring (forty-six miles) is not quite equal to some others, Copernicus is one of the most impressive objects, rising upwards of 12,000 feet, and on all sides divided by concentric terraced ridges, which present every appearance of being enormous land-slips, resulting from the crushing of their overloaded summits, that have slid down in vast fragments, scattering their *débris* over the plateau. We observed corresponding vacancies in the rampart whence these prodigious masses have broken away. In the centre of the plateau stands a group of cones, 2,400 feet and upwards in height. This volcano is evidently the result of a vast discharge of molten matter, which has been ejected from the centre of an extensively upheaved portion of the lunar crust; and for 100 miles on every side we saw evidences of the vast extent and force of this disruption. Bright streaks radiate from filled-up fissures, as around Tycho; whilst frightful chasms gape wide in all directions.

We travelled farther north, until the magnificent chain of the Apennines burst upon our view. Well might it be called the backbone of the Moon! Extending for some 450 miles, we saw this mountain-group rising gradually from a comparatively level surface towards the south-west, in the form of innumerable mountains, which increase in number and altitude towards the north-east, where they culminate and suddenly terminate in a sublime range of peaks, whose altitude forms one of the most terribly grand and romantic scenes which the imagination can conceive.

We then journeyed to the north-east face of the range, which terminates abruptly in almost vertical and precipitous sides. Intensely black steeple-like shadows were cast over the

plain, extending fully 90 miles, till they lost themselves in the general shading due to the curvature of the lunar surface.

Our feelings were indescribable, for nothing could exceed the sublimity of this range, many of the mountains rising to heights of 18,000 and 20,000 feet at one bound from the plain at their north-east base. Again we saw on every side numerous craters, yawning chasms, and profound abysses. Becoming bewildered at the grandeur of the spectacle, and overcome with amazement, we begged our aërial companion to carry us back to Earth again.

Our friends were very glad to see us, and amongst them Mr. Crosby Lockwood, who presented me with a wonderful Lunar picture, by Nasmyth, of Tycho and its surroundings. (Fig. 40.)

I must just mention that in order to enjoy such a visit as I have described, it would be necessary to be able to live for the time without air and food; for the Moon has no atmosphere and no water, consequently neither animals nor plants can exist there, as I will explain. The refraction of our atmosphere is such that the image of the Sun is seen several minutes before it rises, and is also visible above the horizon several minutes after it has set. If, therefore, the Moon were surrounded by such an atmosphere as our own, when it passed in front of a star we should see the latter shining for some minutes after it had really been concealed; and such a star after occultation would remain four seconds beyond the edge of the Moon, if its atmosphere were so attenuated as not to exceed the highly rarefied condition in which air exists in the receiver of an air-pump after exhaustion by our most perfect pneumatic apparatus. Yet this thin film, a thousand times more attenuated than any atmosphere, is not present at the surface of the Moon; for stars are observed to pass behind its disc, without their light being refracted even for a second; and, as no atmosphere exists, there can be no twilight;

sudden pitch-black darkness and glaring sunshine mark the changes from day to night. No singing of birds or other musical sounds can be heard there. Whistling winds and the thunder's peal are quite unknown; neither voice nor speech breaks the dread monotony, but eternal silence reigns.

If air and water had been present on the Moon, we should seldom, if ever, have seen its face. For as it turns on its axis only once in a month, for 336 hours every portion of its surface is under blazing sunshine, until the heat cannot be less than 300° Fahr., and then for 336 hours not a ray reaches those same portions, so that the cold becomes some 200° *below zero*. These changes from intense frost to excessive heat would give rise to an inconceivable amount of evaporation, manifesting itself by dense mists and thick clouds, which would cover up the whole surface, and not a mountain-top would peer through its density. Instead of which, every rock and every mountain is always as sharply defined as if it were carved out of molten silver. Rivers and seas would also be seen through our telescopes, and all the phenomena connected with them. But nothing of the kind appears; it is quite certain, therefore, that no water exists at present on the Moon.

Doubtless it has struck my readers as rather remarkable that astronomers should be able to measure the heights of the mountains of the Moon; but I think this will be easily understood when it is known that these altitudes are ascertained by measuring their shadows. When light falls upon any object at an angle of 45°, the length of the shadow exactly equals the height of such object; if the sunshine, therefore, be falling upon these mountains at such an angle, we have only to measure the length of this shadow with a micrometer, and see what fraction it is of 2,160 miles; and then we know at once the height

of the mountain in proportion to the Moon's diameter. Or should it not be shining at an angle of 45°, by a simple trigonometrical calculation the proportion could be ascertained. Beer and Mädler measured the heights of some 1,500 lunar mountains.

Perhaps my readers will appreciate this better from the relation of a little incident. I was walking with a friend by the sea-shore at Yarmouth, when we passed the monument erected there in honour of Nelson. The Sun was getting low in the horizon, and the shadows, consequently, were very long. I suggested that we should try whether we could not ascertain the height of the column by its shadow, notwithstanding its excessive length.

Putting an umbrella about three feet long upright into the ground, we found that its shadow was nine feet long, or three times its height. It was quite certain, therefore, that the shadow of the monument was also three times its height, and this shadow measured roughly we made 148 yards; and therefore concluded that the column was about 148 feet high. Then going to the man in charge of the monument, we asked him the height, and he told us 144 feet: we were, therefore, only four feet out, though we had no other measuring-rod than an umbrella for a shadow 432 feet long.

After this little story I think you will not doubt the ability of our eminent astronomers, with exquisitely delicate and beautiful instruments, to measure the mountains of the Moon by their shadows, at whatever angle the Sun may be shining upon them.

Before quitting the subject of the lunar surface, I must not omit to refer to the great importance and value of the researches of our countryman, Mr. Neison, who in the work published by him in 1876, entitled "The Moon: the Condition and Configuration of its Surface," gives *complete description* of our satellite, founded in great

measure on his own observations, and accompanied by a series of elaborate selenographic drawings. The appearance of this work forms an epoch in the history of the subject.

And now as to this "Lesser Light" being appointed for

SIGNS AND FOR SEASONS.

There seems to me no doubt that all the time the Earth's strata were forming, as hitherto described, the Moon was undergoing processes to fit it for its present office, and that probably it had cooled down to nearly its present condition by the end of the Carboniferous period. And from what I have just said in reference to the non-existence of air and water, it will be seen that, had our satellite possessed them then, it would not have been so good and so useful a reflector as it is now. In this respect the mountains are also of much importance in affording so many points of radiance. Had the Moon been smooth, it would have been something like a ball of polished silver, which glitters in one spot only in the sunshine; whereas one frosted reflects the light from the whole surface. The mountains of the Moon are but little more in comparison to its bulk than this slight unevenness of the frosted silver ball.

Here I must pause for a moment to notice how many evidences there are of forethought and design throughout Nature; and though every great process is, doubtless, brought about by fixed laws, yet such laws are again modified by others, which elaborate infinite varieties of form and arrangement. Wheels work within wheels to make up the magnificent and perfect machinery of the Universe; and the Divine power which sets them in motion equally controls and regulates all their movements.

The Moon is to the sailor an object of importance; for by it he can ascertain the longitude of any place. Tables are prepared and published in the "Nautical Almanac,"

which give the exact position of the Moon at Greenwich in reference to the fixed stars for every third hour, day and night, throughout the year. Much care, great mathematical labour, and constant lunar observations are required in the compilation of these tables; and though they still are not perfect, yet for practical purposes they may be considered nearly so. And, therefore, by means of this Almanac, with a good chronometer and perfect instruments, the mariner can ascertain his longitude.*

Besides giving us light, the Moon has a most important part to play; for while the Sun keeps the atmosphere in constant and healthy circulation, through the agency of the winds, so the Moon, by being the chief producer of the tides, performs an analogous service to the waters of the seas and the rivers flowing into them—I said chief, for the Sun takes a lesser part in their production. I feel that I cannot do better than quote at length a splendid description by Nasmyth† of the value we ought to attach to tidal influences. He says :—

"We ought to place the highest value on the services of the Moon. But for its aid as a mighty scavenger, our shores, where rivers terminate, would become stagnant deltas of fatal corruption.

"Twice (to speak generally) a day, however, the organic matter which rivers deposit in a decomposing state at their embouchures is swept away by the tidal wave; and thus, thanks to the Moon, a source of direful pestilence is prevented from arising. Rivers themselves are providentially cleansed by the same means, where

* In 1714 the British Government offered to any one inventing a method of determining the longitude at sea £10,000 if the error did not exceed one degree, £15,000 if it did not exceed forty minutes, and £20,000 if it did not exceed half a degree. John Harrison, the son of a carpenter, won the highest prize by inventing the *first marine chronometer* in 1735, which he brought to the required state of perfection in 1767.

† I cannot sufficiently express my admiration of Nasmyth and Carpenter's work on "The Moon." The illustrations are beautifully executed photographs, which excel all other representations that have ever appeared of the *mountains or plains* of our satellite. (Murray.)

they are polluted by bordering towns and cities, which, from the nature of things, are sure to arise on river-banks; and it seems to be also in the nature of things that the river traversing a city must become, more or less, its sewer.

"The foul additions may be carried down by the stream in its natural course towards the ocean; but where the river is large, there will be a decrease in velocity of the current near the mouth, or where it joins the sea, thus causing partial stagnation and consequent deposition of deleterient matters.

"All this, however, is removed, and its inconceivable evils are averted, by our mighty and ever-active 'sanitary commissioner,' the Moon. We can scarcely doubt that a healthy influence of less obvious degree is exerted in the wide ocean itself; but, considering merely human interests, we cannot suppress the conviction that man is more widely and immediately benefited by this purifying office of the Moon than by any other."

But the sanitary service, says Nasmyth, is not the only one that the Moon performs through the agency of the tides. There is the work of tidal transport to be considered. Upon tidal rivers and on certain coasts, notwithstanding wind and the use of steam, a very large proportion of the heavy merchandise is transported by that slow but powerful "tug," the flood-tide; and a similar service, for which, however, the Moon is not to be entirely credited, is done by the down-flow of the ebb-tide. Large ships and heavily-laden rafts and barges are quietly taken in tow by this unobtrusive prime-mover, and carried from the river's mouth to the far-up city, and from wharf to wharf along its banks. Thus a vast amount of mechanical work is gratuitously performed, the cost of which, if it had to be provided for by artificial means, would have to be counted by thousands, and possibly millions, of pounds annually.

Tides and Weather.

Let me take this opportunity of saying that, though we owe so much to the influence of the Moon, it is a popular

error to suppose that it affects the weather; and, strange to say, this error is so generally believed in that it is very difficult to convince folks to the contrary, for they say, "If it affects the tides, why should it not affect the weather?" I think, however, our little diagram (Fig. 41) will set the matter at rest.

First, then, please to notice that the tides are caused by the attraction of *gravitation*.

The Moon when going round its orbit is sometimes in

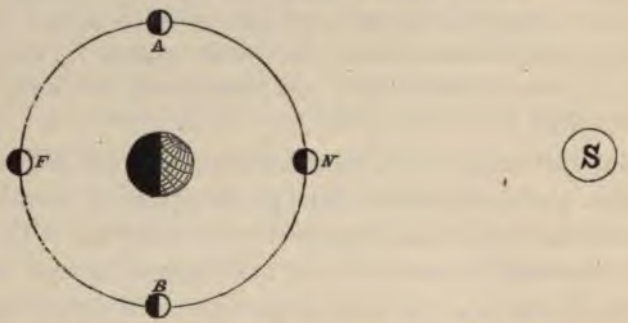


Fig. 41.—Illustrating the Moon's Phases and the Tides.

a direct line with the Sun, as at N and F. Then we have spring-tides, because the united attraction of both Sun and Moon causes the waters to rise on the side of the Earth next to them; and on the opposite side, because it draws away the Earth from the waters, which, therefore, appear to rise to a corresponding height. This occurs first of all at New Moon, N. In a week the Moon is in its First Quarter, A, and then we have what are called neap tides; for the Sun's and the Moon's attraction being at right angles to each other, the waters under the Moon are prevented rising so high as before. After a fortnight it is at F, or Full Moon, and then there is another spring-tide; and at the Last Quarter, B, a second neap-tide. And thus every month

do these various positions of the Moon affect the height of the tides. You will see, however, what a different thing this is from causing it to rain or to discontinue doing so. If the weather were affected by the Moon, it ought to be so periodically, like the tides. Say, for instance, if it were fine once at Full Moon, then it ought always to be so; and if wet once at New Moon, it ought always to be so. But we know that we have every kind of weather in every different phase of the Moon; and such erratic influences are not in accordance with the order and regularity of the great operations of Nature.

Next, look at our diagram, and you will see that the Moon like the Sun must shine on *half* the globe at once. If, then, our satellite affected the weather at its different phases, there ought to be rain or sunshine on half the Earth; but we know that even on our own little island the difference in the rainfall is so great that at Keswick it amounts to 75 inches a year, and at London only to 25. How can our friends holding the lunar theory of weather explain this?

Again, the Moon's phases are simply caused by our seeing more or less of the sunshine upon its surface, and not by sudden changes causing a remarkable alteration in the electrical or chemical condition of our atmosphere. In fact, so gradually does its sunny side turn towards us, that no one but an astronomer could tell when the Moon had really reached its first, second, third, or fourth quarter. It must be also noted that we always see the same face, and on that face no change for certainty has been recorded since the Moon was first observed through a telescope.

Never again, then, say, "The Moon changes to-morrow, perhaps we shall have fine weather." Pray remember that it does not change at all, but is one of the most conservative bodies in Nature.

As a time-keeper, Nasmyth says it renders us the greatest

service, by enabling us to fix dates to historical events of great importance; for with many ancient people the Moon was the chief time-keeper, as it is with some even now. The calendars of such people being lunar ones, all their events are reckoned and dated by Moons. Often does the Moon clear up a mystery, or decide a disputed point in chronology, by furnishing the accurate date of an ancient eclipse, which was a phenomenon that always inspired awe, and secured for itself a careful record, thereby affording a clue to the exact time when an emperor was born, a battle fought, or a kingdom conquered.

After these descriptions of the two great lights, I think my readers will see that Moses has described them, and the offices to which they were appointed, with wonderful exactitude; and the marvel is that so much information is given in so few words—a further proof, to my mind, that they are of Divine origin. Let me repeat them :—

"And God said, Let there be lights in the firmament of heaven to divide the day from the night; and let them be for signs, and for seasons, and for days, and years."

CHAPTER VII.

"He made the Stars also."

How graphically this short sentence tells the story of the creation of other worlds than those we have been considering! Yea, more; it indicates also that the Stars, up to that period concealed from the Earth, then blazed forth in all their glory. The thick vapours surrounding the globe having been dispersed, the Sun and Moon and Stars were all visible; and though man was not yet created to see them, they were not shining in vain, for great processes necessary to fit the Earth for his advent had still to be carried on, in which the direct influences of the Sun and Moon would play an important part.

When we speak generally of the stars, we mean both the planets and fixed stars, because the largest planets appear only like points of light to the naked eye.

On turning our present powerful telescopes upon them, however, we see that they are worlds similar to our own, and some of them far more magnificent. It would be contrary to the object of this work for me to treat of all the planets in our system, although it is difficult to refrain from doing so, as each has its own special and interesting peculiarities. But I must refer my readers to Proctor, Lockyer, and other well-known astronomers for information respecting them. I wish, however, that I could for a short time descant upon the seas and continents seen upon Mars when in opposition, and

when it is sometimes not more than 35,000,000 miles distant. And I should like to notice, if I had space, the melting of the snow at its poles—proving it to be so similar to the Earth in its physical arrangements that we could almost imagine we see its towns and cities with their busy inhabitants.

Fig. 42.—The Minor Planets.

The asteroids also are extremely interesting objects, and the orbits of 250 are now known.* I remember some years ago being present when the gold medal of the Royal Astronomical Society was given to the late M. Goldschmidt,

* The last minor planet, No. 250, was discovered on the 3rd September, 1885, by Professor Palisa, of the Vienna Observatory. For the names, &c., *of these* asteroids, see a handy little book, "Celestial Motions."

ASTRONOMICAL DISCOVERIES

Relating to this Work since 3rd September, 1885, as mentioned in Note on page 224, &c. &c.

Twenty-one more Minor Planets have been discovered; the names and dates are as follows. All the *previous* names and dates will be found in Mr. William Thynne Lynn's little book, "Celestial Motions" (Stanford).

No.	*Name.*	*When Discovered.*	*Discoverer.*	*Where Discovered.*
251	SOPHIA	1885, OCT. 4	PALISA	VIENNA.
252	CLEMENTINA	1885, OCT. 11	PERROTIN	NICE.
253	MATHILDE	1885, NOV. 12	PALISA	VIENNA.
254	AUGUSTA	1886, MAR. 31	PALISA	VIENNA.
255	OPPAVIA	1886, MAR. 31	PALISA	VIENNA.
256	WALPURGA	1886, APRIL 3	PALISA	VIENNA.
257	SILESIA	1886, APRIL 5	PALISA	VIENNA.
258	TYCHE	1886, MAY 4	LUTHER	DÜSSELDORF.
259	ALETHEIA	1886, JUNE 28	PETERS	CLINTON, U.S.
260	HUBERTA	1886, OCT. 3	PALISA	VIENNA.
261	PRYMNO	1886, OCT. 31	PETERS	CLINTON, U.S.
262	VALDA	1886, NOV. 3	PALISA	VIENNA.
263	DRESDA	1886, NOV. 3	PALISA	VIENNA.
264	LIBUSSA	1886, DEC. 17	PETERS	CLINTON, U.S.
265	ANNA	1887, FEB. 26	PALISA	VIENNA.
266	ALINE	1887, MAY 17	PALISA	VIENNA.
267	TIRZA	1887, MAY 27	CHARLOIS	NICE.
268	Not yet named	1887, JUNE 9	BORRELLY	MARSEILLES.
269		1887, SEPT. 21	PALISA	VIENNA.
270		1887, OCT. 8	PETERS	CLINTON, U.S.
271		1887, OCT. 13	KNORRE	BERLIN.

Dr. Palisa has now discovered sixty of these Minor Planets.

Whilst I am revising this Tenth Edition, another Comet is visible, though only in a telescope, which was first discovered by Olbers at Bremen, on March 6th, 1815, whilst Napoleon was marching from the French coast upon Paris, and was calculated by Bessel to have a period of about 72 years. It was nearest the Sun a month since, October 8th, 1887.

The calculation in reference to the Sun mentioned upon page 190 has been completed, and gives the result anticipated of nearly 93,000,000 miles as its distance.

In reference to the Nebula in the Sword-handle of Orion, page 23, supposed to have been first discovered by Huygens, it is now known that it was noticed by Cysat, of Lucerne, long before, in 1618, though strangely enough Huygens was not aware of this.

[See p. 224.]

of Paris, who had discovered thirteen of these minute planets: he subsequently found another, making fourteen in all. You will notice by my diagram (Fig. 42) that they look more like meteors than planets.

I will, however, consider more fully Jupiter, Saturn, and Neptune, and will commence with

The Giant World,

which so far exceeds our own in size that we sink into insignificance in comparison; for it would take about twelve hundred and eighty such worlds as ours to equal the volume of Jupiter; and though its specific gravity is much less than the Earth's, still, if placed in a balance, it would require three hundred of our worlds to counterpoise it; the diameter is nearly 86,000 and circumference 270,000 miles.

These numbers can be only imperfectly understood unless we try and compare them with familiar objects. Take, then, one of the largest globes used for educational purposes, having a diameter of two feet, and place it upon a table in a room 12 feet high, 18 feet broad, and 24 feet long; the cubical contents of that room would represent Jupiter, and that of the globe the Earth. Or, to help you still further to conceive these magnitudes, we will compare it with Mont Blanc. Now if you will place upon this globe the tiniest grain of sand, say $\frac{1}{100}$th of an inch in diameter, it will represent that mountain, 15,732 feet high. Then look around the room, and see how many grains of sand it will hold; and you will be able to form some comparison between Mont Blanc and Jupiter.

Though this planet is such a monster world, it turns on its axis in less than half the time of our Earth—viz., 9h., 55m., 20s.; therefore any one standing upon its equator would be whirled round at the rate of 27,000 miles an hour. Its orbit round the Sun is more than 3,000 millions of miles, to pass over which it takes nearly 12 years; or, in

correct figures, 4,332 terrestrial days, or 10,484 Jovian days, although it is travelling at the rate of 29,000 miles an hour —that is, 500 times faster than an express train.

And what has this mighty world been created for? will be asked. Is it inhabited, like our own, with intelligent beings, and has it seas and rivers, forests and fields? I cannot give an affirmative to these questions, and am more inclined to believe that at present it is a miniature Sun; or, at any rate, is in a transition state, and something like what I described our world to be during the first period, when the lava was still so hot that the ocean and many of the minerals were in a vaporous condition, surrounding it with a thick cloudy envelope.

That Jupiter has not yet cooled down to the present condition of our globe is a certainty, for many reasons; and one is that its density is so much less in proportion to its size; therefore the minerals—the same as those of which the Earth is composed—are still expanded with intense heat. This may partly be accounted for by its great size taking longer to cool.

The next proof of its internal heat is that we notice some very remarkable and violent changes taking place in its belts; which could only be accounted for by forces inherent in the planet, and to some extent resembling those which are at work in the Solar atmosphere.

These belts are highly interesting phenomena, and their general arrangement, according to Proctor, is this:—A bright belt runs across the middle of the disc, which goes by the name of the equatorial belt. On either side of this there are commonly two dark belts, of a coppery, ruddy, and even purplish tint. Then usually follow several alternate light and dark streaks, up to the polar regions; the dark ones being ruddy, the light intermediate zones yellowish, and *almost white* near the equator, but greyish towards the polar

regions. These regions are commonly bluish, the blue colour being at times, in some telescopes, singularly pronounced.

In Fig. 43 there are four views of Jupiter's belts as they appeared to Mr. G. T. Gwilliam in a reflecting telescope of 6½

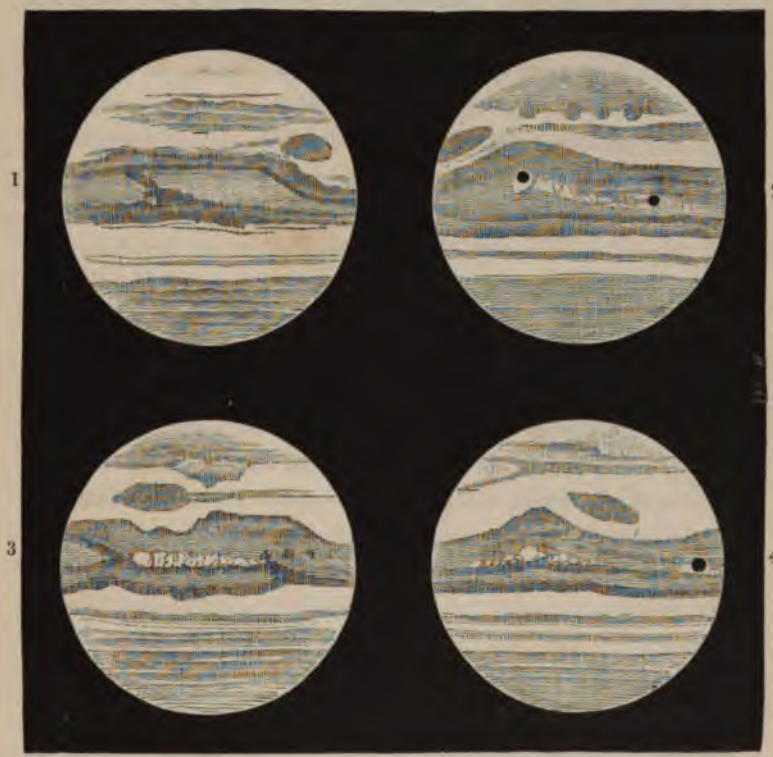


Fig 43.—Jupiter in 1879: (1) Aug. 21, 12·30 a.m.; (2) Aug. 29, 12·5 a.m.; (3) Sept. 3, 10·15 p.m.; (4) Sept. 7, 12·0 midnight.

inches aperture on the nights of 21st and 29th August, 3rd and 7th September, 1879. Shadows of the first and second satellites were seen in transit over the disc on 29th August, and that of the third satellite on 7th September. This will illustrate the remarkable changes that occur in a very short time.

By watching these belts continually, we find that some mighty and violent internal convulsions are going on, and by their constant study we may hope in time to know much more about this planet.

Some writers have calculated that Jupiter's atmosphere is 20,000 miles in height, and that therefore the pressure upon its surface is so great that water might exist as a fluid at ten times its temperature when at boiling-point here; hence the hot vapours rushing upwards towards the cold are transformed into dense clouds or perhaps snow before again descending, and that the difference between the reflection of white clouds and that of sandstone is equal to the difference between the light of Jupiter and of the Moon.

Proctor adduces much evidence to show that Jupiter is still a glowing fluid mass, bubbling and seething with the intensity of its primæval fires. Not otherwise, he says, could we explain its enormous masses of cloud continually being sent up, to be gathered into bands under the influence of the swift rotation of the giant planet, and swayed by influences of such energy that intermediate belts, thousands of miles in width, are closed up in a single hour. The tremendous character of these motions may be easily conceived when we consider that they are visible through our telescopes at a distance, when Jupiter is in opposition, of nearly 500,000,000 miles, which would take us more than 1,000 years to pass over, even travelling day and night, at the rate of 55 miles an hour. But though Jupiter cannot yet be in a suitable condition for habitation, there is every reason why it should become so hereafter, when the other great processes which I have described in reference to the Earth have taken place.

To his satellites he must appear a magnificent luminary; for to the outermost his surface would exceed that of the Sun, as seen by us, sixty-fold; whereas to his nearest moon *his apparent area* would be 1,400 times larger than our

Sun! And he may supply to them much heat as well as light.

The sizes of these satellites are slightly larger than that of our Moon (the third being the largest, and somewhat more than 3,000 miles in diameter). Consequently their smallness would have caused them to have cooled down to the same extent, if they had not been in such close proximity to their giant primary. We should not, therefore, be stretching the imagination too far if we thought that these satellites were beautiful worlds, with an abundant vegetation, and diversified, as our Earth is, with seas, mountains, rivers, valleys, and plains, and peopled even with intelligent beings who could appreciate and admire the glories of their sky.

The Ringed World.

Some of the heavenly bodies seen through the telescope for the first time by a novice in astronomy excite in him but little admiration, because they are not properly understood; but by-and-by, when he has become accustomed to the use of the instrument, and knows what he has to look for, every object affords him much gratification.

Saturn, however, is quite an exception to this remark; for no one can see this wondrous planet, even for the first time, without exclaiming, "How beautiful! how wonderful!" especially if he be looking at it through a telescope which shows several of the moons, as well as the lovely bright rings so gracefully encircling it (Fig. 44). Proctor tells us that it so fascinated him that he will never forget his sensations, and we know how well he afterwards wrote about it.

It is not so large as Jupiter, and yet its globe is more than 700 times greater in bulk than our Earth. Like its giant brother, it rotates upon its axis very rapidly, the length of its day being only 10¼ hours. Its distance from the Sun

when greatest, or at its aphelion, is over 900,000,000 miles. To conceive of this space, we must suppose it possible to have the opportunity offered us of travelling to Saturn in a manner similar to that by which we reached the Moon, and passing through space at the rate of 50 miles an hour, we should be more than 2,000 (!) years performing the journey. The light Saturn receives from the Sun is ninety times less than that

Fig. 44.—Saturn.

which reaches the Earth; and, like Jupiter, it has not yet cooled down sufficiently for the deposition on its surface of its vaporous atmosphere, which in all probability is in a highly heated and attenuated condition, for the whole planet weighs less than the same volume of water would do. The old books on astronomy speak in glowing terms of the glories of the Saturnian sky as seen by its inhabitants, with the luminous rings and the eight satellites all shining at the same time; but this, though very poetic, must now be given *up as contrary* to scientific fact, since Saturn is not yet in a

condition suitable for habitation. On the other hand, it may be the centre of a miniature solar system, and its attendant worlds may be adorned with every natural beauty to enchant their inhabitants. Fig. 45 shows the orbits of these satellites.

Of its rings I will just say a word or two. Their united breadth, according to Lockyer, including the inner dark one, is 37,570 miles, and the inner dark ring is 9,760 miles

Fig. 45.—Sectional View of the Orbits of Saturn's Satellites.

from the body of the planet. Though these rings are so wide, their thickness at such a great distance cannot be measured. Sir John Herschel says that it does not exceed 250 miles. Fig. 46 will give some idea of the comparative diameters of the planet and his rings.

When we reflect upon this system of worlds travelling round the Sun at the rate of 514,000 miles a day, and yet each one retaining its appointed place and performing its own appointed motions, our minds must be filled with

admiration of the mighty power of the Creator who could ordain laws to guide and control this prince of planets, which passes over an orbit of more than 5,000,000,000 miles in about 29½ years, or more correctly, 10,759d., 5h., 16m., 5s., with such precision that we can fix its arrival at any particular point, almost within a second of time. If a railway train, having to perform a journey of some

Fig. 46.—Sectional View of Saturn and Rings.

300 miles, arrives at its terminus within a few minutes of its time, it is thought very punctual; but try to imagine passing over 5,000,000,000 miles at the rate of more than 21,000 miles an hour, and yet to complete the journey within a fraction of a second, according to laws ordained by the great Ruler of the Universe!

"These are thy glorious works, Parent of good!"

I should like just to pay a short tribute to Sir William Herschel for the discovery of Uranus on March 13th, 1781; *he at first* called it "Georgium Sidus," in compliment

to his friend and patron, George III. This not being accepted by foreigners, "Herschel" was proposed by Laplace, and ultimately "Uranus" was agreed upon by the scientific world.

THE FAR-OFF WORLD.

The *discovery* of Neptune was one of those interesting coincidences to which I have before referred, of two men, each without the knowledge of what the other was doing, attempting to unravel some great secret of Nature, and each accomplishing it alone and unaided by the other.

For some years, from an unknown cause, irregularities had been noticed in the motion of the planet Uranus; and astronomers, both in England and France, were trying to discover their origin. It was strongly suspected that there was a planet beyond Uranus, but up to 1841 no definite information had been obtained. In that year a young man, who was a student of St. John's College, Cambridge, resolved to attack the question, and made an entry in his diary to that effect. But he did not find sufficient leisure to do so until after he had taken his degree (as Senior Wrangler) in January, 1843; and then he devoted himself for a year and three-quarters to this interesting problem, bringing to bear upon it all the resources of his consummate mathematical knowledge. After much patient and persevering application, he forwarded to the Astronomer Royal in October, 1845, some provisional elements for a planet revolving round the Sun at such a distance, and of such a mass, as he thought would account for the observed perturbations of Uranus. This was virtually the solution of the problem theoretically. But, unfortunately, neither the result nor any of the circumstances attending it were made public. Scientific men did not then know what a bright star was rising in the horizon of Cambridge, which would afterwards

illuminate the world with a flood of light, revealing mysteries which had puzzled philosophers for centuries. I need not tell my readers that this young Wrangler of 1843 is now Professor Adams.

In the summer of this same year, 1845, when Adams had forwarded his calculations to Sir George Airy, the then Astronomer Royal, M. Le Verrier, of Paris, turned his attention to these anomalous movements of Uranus, and in November published his first memoir to prove that Jupiter and Saturn could not be the sole causes of such perturbations.

Working still at the problem, in June, 1846, he published his second memoir, to prove that an exterior planet was the cause of the residual disturbance. A copy of this memoir reached our Astronomer Royal on the 23rd of June, eight months after he had received that of Adams; and so closely did the two deduced elements accord, that he wrote on July 9th to Professor Challis, of Cambridge, to suggest the immediate employment of the large Northumberland telescope in a search for the planet. The proposal was agreed to, and a systematic search was commenced on July 11th; and Challis, not being in possession of the Berlin star-map for that particular part of the heavens, set to work to construct one.

Whilst making the necessary observations for this star-map on August 4th, he dotted down the veritable planet upon his chart, supposing it then to be a fixed star. On September 29th he came across the same supposed star, which subsequently proved to be the sought-for stranger, which, though unknown to him, Galle had already discovered.

Let us return to Paris, and see what is taking place there. M. Le Verrier in August published a third memoir, containing revised elements, in which particular attention was paid to the probable position of the planet in the heavens. On September 23rd he wrote to Encke, at the Berlin Observatory, with a summary of the principal points of this memoir,

requesting his co-operation in searching for the planet. Fortunately Encke had just become possessed of Bremiker's star-chart for hour xxi. The very next night his assistant, Dr. Galle, came upon a star of the eighth magnitude which was not marked in the chart, and which of course particularly attracted his notice. Observing it with great attention, and finding it change its place among the stars, he compared its position with the elements furnished by Le Verrier, and to his great joy he was convinced that it was the looked-for world.

The sensation this caused through Europe can scarcely be conceived. Honours were literally showered upon Le Verrier by crowned heads and learned societies. The results of the investigations of Adams and the observations of Challis not having been hitherto published, the French supposed that the glory of the discovery was due to them alone, and the eminent Arago took a prominent part in putting forward this claim.

Dates, however, are important things, and quite outweigh all arguments. The Astronomer Royal could show that he had received the deduced elements calculated by our young student eight months before he had received those of the renowned astronomer, Le Verrier, and that with those elements Prof. Challis had seen the planet nearly six weeks before Dr. Galle. To the latter, however, must be accorded the honour of having first ascertained that this star of the eighth magnitude was the far-distant wanderer.

So we must divide the honour between England and France. Adams was the first to calculate the place, and Galle (searching from the instructions of Le Verrier) the first to find the planet, which by common consent was afterwards named Neptune.

And now, marvel of marvels! so exactly had these two master-minds calculated the planet's position, that it was found between the two points fixed upon, but nearer to Le Verrier's point by only thrice the apparent diameter of the

Moon's disc in the sky. Who will, after this, dare to ask whether the astronomical calculations which so amaze the uninitiated are "guess-work"?

Fig. 47.—Relative Distance of the Earth and Neptune from the Sun.

Well, Neptune being found, it was soon easy to ascertain its size, weight, and distance. Its diameter is 35,000 miles, and its circumference about 108,000 miles. Its volume is 105 times greater than that of the Earth; but, like those other giant worlds, its specific gravity is so much less (viz., about a sixth) that it only exceeds the Earth in weight about 16¾ times.

Its distance from the Sun is about 2,740,000,000 miles; so that if Noah had started off to go there, at the rate of an express train, he would have only just reached it.

The year of this planet is nearly equal to 165 of ours; therefore, should the allotted life of an inhabitant of one of his satellites be seventy of the planet's years, in that time he would live some 11,500 of our years. What an infant even Methuselah would seem to such a Neptunian!

The Fixed Stars.

When walking out on a clear night, looking up at the sky glittering with such glorious galaxies, how few there are who think that all those bright points of light are suns! And yet such they all are, excepting five planets which are visible to the naked eye — Mercury, Venus, Mars, *Jupiter, and* Saturn; and of these very seldom more than

three are above the horizon at the same time. Numberless as the stars appear to our unaided eyes, we are amazed, when we look through a telescope, to find that myriads upon myriads more burst upon our sight. We call them *fixed stars* because the various groups, termed *constellations*, do not alter their apparent relative positions as our Earth goes round the Sun, although at Midsummer we are about 186,000,000 miles distant from our position at Christmas.

With this large base-line an exceedingly small parallax of somewhat less than a second has been obtained of a very few of the stars, the nearest of which, Alpha Centauri, is about 30 billions of miles distant.* Hitherto I have made the rate of an express train a means of conveying some idea of the distance of the planets. Now suppose yourself able to ride upon a cannon-ball travelling at the rate of 2,000 feet a second, it would take you more than two millions of years to get to this nearest fixed star; the light from which takes about five years to reach the Earth, although it flashes through 186,000 miles of space while the clock is ticking once. Lockyer says that stars could be detected by Lord Rosse's telescope, the light from which has taken sixty thousand years to get to us; and, therefore, we should not see them as they are now, but as they were sixty thousand years ago; for light carries forward with it the image of the body from which it radiates, as photography so well proves.

Suppose we were transported at this moment to a very distant star, and had eyes or an instrument sufficiently powerful to see our Earth, the scenes which we should witness would not be those of the present time, but those that were taking place here thousands of years ago, and, it might be, Adam and Eve in the garden of Eden. And then, suppose we were next conveyed to a nearer star, to which the light from our Earth would take four thousand years to travel,

* This is the result of the most recent and probably the most accurate determination made by Dr. Gill, of the Royal Observatory, Cape of Good Hope.

the scene carried forward with this light might be Abraham offering up Isaac. From a nearer one would be seen the Assyrian kingdom in all its glory; then, from still nearer ones, in succession, would be seen the events of the New Testament, the destruction of Jerusalem, the Norman conquest of England, and, in fact, every historical event down to a few years ago, when from Alpha Centauri the Russian army invading Turkey would be seen crossing the Balkans.

This may seem intensely fanciful, yet it really is not so; for sometimes we see all the phenomena of the eclipses of Jupiter's satellites some fifty minutes after they have really taken place;* and if our instruments were powerful enough, we should see what the inhabitants of those Jovian worlds had been doing nearly an hour before. One writer, extending these thoughts, suggests that the omnipresent Deity actually sees thus depicted by light in space every action that has taken place from the beginning of time.

Many of these distant suns are much larger than our Sun. Sirius, the beautiful Dog-star, is (so far as can be judged by its amount of light) nearly 3,000 times larger, and therefore its system of dependent worlds may be more important than those which form our Solar System. Its planets may far exceed ours in size, and revolve at far greater distances; for such a sun would throw its beams of light and heat much beyond the distance of our Neptune.

We find that some of these stars are double, and revolve around their common centre of gravity; so that the planets in their systems have actually two suns in their sky, and sometimes, therefore, they have no night, for one sun is rising when the other is setting. At other seasons they will have day and night, but two suns rising and setting at the same time; and at others these two suns will be in different parts of their sky, and they will have two noons.

* *It must be remembered*, too, that these eclipses are also seen 16 minutes *35 seconds later on the opposite side of our orbit* (see p. 56).

How varied, and we may safely also say how beautiful, must be all the circumstances connected with such worlds!

I have thus presumed that these suns have worlds revolving around them, and not without reason. Why, otherwise, were these glorious bodies created, being to us but points of light? So perfect are astronomical calculations, that I can give you the exact fraction of light we receive from the nearest fixed star, Alpha Centauri, which is (according to Dunkin) the $\frac{1}{11,000,000,000}$th of that derived from the Sun. There must be, therefore, a higher mission given to these stars—that of being sources of light, life, and heat, to worlds like ours. And can we form any estimate of what these worlds are like? I think we may; for Spectrum Analysis has revealed to us the composition of those distant stars. Sodium, magnesium, calcium, iron, bismuth, hydrogen, and many other terrestrial elements, are there; and as we find our Earth is composed of the same minerals as our Sun, so may the planets revolving round Alpha Centauri, Sirius, Aldebaran, Betelgeux, and all the rest, be composed of the same minerals as their suns.

May not the presence of iron indicate probable industries of every variety? And would not sodium tell of seas, and hence of rivers, with all their accompanying vegetation? Would not calcium remind us that those seas might teem with life, and that the Mollusca, with their shells of carbonate of lime, would form strata of chalk, afterwards to be calcined into marble? And with that marble, might not palaces arise, and noble architects to rear them? However imaginary this may appear, there are considerations which render it quite probable.

Surely we need not now think that this Earth, which is but an infinitesimal atom in space, is the only spot where intelligent beings are living to enjoy and admire the beneficent and wondrous works of the great Father of the Universe.

Nay! nay! As there are millions upon millions of suns, so may there be millions upon millions of beautiful worlds; and we may believe that hymns of praise are continually ascending up from each of them to the throne of their Maker and their God.

"And these are suns! Vast, central, living fires,
Lords of dependent systems, kings of worlds
That wait as satellites upon their power
And flourish in their smile. Awake, my soul,
And meditate the wonder! Countless suns
Blaze round thee, leading forth their countless worlds!
Worlds in whose bosoms living things rejoice,
And drink the bliss of being from the fount
Of all-pervading love. What mind can know,
What tongue can utter, all their multitudes?
Thus numberless in numberless abodes,
Known but to Thee, blest Father! Thine they are,
Thy children and Thy care, and none o'erlooked
Of Thee. No, not the humblest soul that dwells
Upon the humblest globe that wheels its course
Amid the giant glories of the sky.
None can escape the kindness of Thy care,
All compass'd underneath Thy spacious wing;
Each fed and guided by Thy powerful hand."

PROFESSOR HENRY WARE, U.S.

CHAPTER VIII.

"Let the Waters bring forth abundantly."

It would be very difficult to describe the sensations of the holy prophet whilst enveloped in a cloud after the late glorious vision.

Probably he was left some time to contemplate the revelation he had received of those orbs of light and life, and inwardly to adore, admire, and praise their great Creator.

The veil is again lifted, and he sees the world lighted up with sunshine, the Earth clothed with verdure, and the sea teeming with life.

Particularly notice, however, that Moses does not say that this was the first dawn of animal life, but simply that the command had gone forth that the waters should bring forth abundantly—literally, *swarm forth swarms.*

This passage seems to relate to a great increase in the number of the genera of marine animals, and also to the increase of insects and of reptiles both of sea and land.

Very often great mistakes have been made and errors persisted in for centuries from a want of careful reading of passages. Had Moses written it thus, "And God now created every living thing that moveth in the waters," there would have been a great discrepancy between his statement and geological facts. This, however, he does not do, and much blame must be attached to writers upon the subject of creation who have thus worded their descriptions of God's work at this period.

Therefore there is no inconsistency between the geological and the Biblical statements. Before the Carboniferous period all the four great sub-kingdoms were largely represented in the sea, and some of them in vast numbers; fishes being abundant in the time of the Old Red Sandstone. It seems to me probable that this was the first time Moses, in his series of visions, saw marine life; and as numerous species of the Secondary period floated on the surface of the waters, he describes what he actually saw.

Hitherto I have intentionally avoided speaking of the fauna of the *previous* strata, in order that I might the better follow out my argument and narrative. I will now, however, go back to the time when the first forms of animal life existed, or at any rate appear to have existed, so far as our present knowledge goes.

In some of the early chapters I described the formation of the igneous and metamorphic rocks, and spoke of the Laurentian as containing the oldest known animal remains. For a long time it was thought that no organic remains would be found below the Silurian strata, and that if they had existed before that period the heat from below had entirely destroyed all vestiges of them. In 1859, however, Sir W. Logan observed what he considered to be an organic body, much resembling the Silurian fossil called *Stromatopora rugosa*. It had been obtained the year before by Mr. J. McCulloch, at the Grand Calumet, on the River Ottawa. This fossil was examined in 1864 by Professor Dawson, of Montreal, who detected in it, by aid of the microscope, the distinct structure of a Rhizopod or Foraminifera. Dr. Carpenter, Professor Rupert Jones, and many others, have since confirmed this opinion, comparing the structure to that of the well-known nummulite.

It appears to have grown one layer over another, and *to have formed* reefs of limestone, as do the living coral-

building polyp animals. Parts of the original skeleton, consisting of carbonate of lime, are still preserved; while certain interspaces in the calcareous fossil have been filled up with serpentine and white augite (Fig. 48).

Fig. 48.—Magnified and Restored Section of a Portion of *Eozoon Canadense*. The shaded portions show the animal matter of the chambers, tubuli, canals, and pseudopodia; the unshaded portions, the calcareous skeleton.

On this oldest of known organic remains Professor Dawson has conferred the name of

EOZOON CANADENSE,

of which he has given a full and most interesting description in his "Chain of Life," and to it I am indebted for the

above drawing. Its antiquity is such that the space of time which separated it from the Upper Cambrian period may be equal to the time which elapsed between the Cambrian and the Tertiary period. Can we find figures to represent these periods in years? I fear not; for they must have been millions upon millions. These Lower Laurentian rocks are 20,000 feet, or nearly four miles, in thickness, and no other fossil has yet been found in them; also in the Upper Laurentian series, 10,000 feet in thickness, no organic remains have been found. Next follow the Huronian series, 18,000 feet thick, and no organic remains have yet been found in any of the beds.

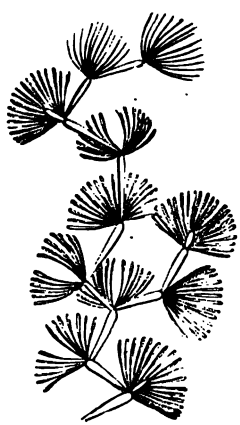


Fig. 49.—*Oldhamia antiqua.* (Forbes.)

Thus, then, we have these three series, amounting to nearly 50,000 feet, or nearly ten miles of the Earth's crust, without any animal or vegetable remains. In the Lower Cambrian, which are several thousand feet in thickness, organic remains begin to show themselves; the oldest of which, found in Wicklow, in Ireland, is represented in Fig. 49, and to it Professor Edward Forbes gave the name of Oldhamia. In the Lower Cambrian of South Wales numerous fossils have of late years been found by Dr. Hicks, who has catalogued species of no less than seventeen genera, embracing various Crustaceans, besides bivalves, univalves, zoophytes, and sponges.

Of the Foraminifera I shall have more to say when I speak of the formation of chalk; and will pass on to consider

CORALS,

which existed at a very early period, and have lived in all ages. *The very first forms* of them are allied to the little artificers

of the present time, whilst so many tribes of the animal kingdom have utterly passed away. These coral tribes and families are very numerous, but I shall only speak of three.

First, the lowest tribe of Molluscs, called Bryozoans, which produce a delicate coral-like framework, sometimes branching and moss-like, and at other times in broad plates, thick masses, and thin incrustations.

Second, animals related to the little Hydra of fresh waters, and called Hydroids, which, as Agassiz has shown, form the very common and often large corals called Millipores.

Third, Polyps, the most important of coral-making animals, and the principal source of the coral reefs of the world.

The tribe of coralloid molluscs called BRYOZOANS formed much of the limestone in the early stage of the world, and though they are not now of much importance in reef-making, yet many beautiful forms are still generated by them.

Dr. Dana gives this description of them:—They are very small animals, and look much like Hydroids. Although belonging to the sub-kingdom of Molluscs, they are externally polyp-like, having a circle or ellipse of slender tentacles around the mouth. But in their internal structure below the head they are molluscs. They form delicate membranous or calcareous corals, made up of minute cabin-like cells, which are either very thin crusts on sea-weeds, rocks, or other supports, or they are slender moss-like tufts, or graceful groups of thin curving plates, or net-like fronds, and sometimes thread-like lines or open reticulations. Occasionally, however, they make large massive corals from the growing of plate over plate. One of the massive species, *Escharella variabilis*, is common on the coast of the United States from Cape Cod southward.

The first two figures in the following engraving (Fig. 50),

from Dana's work on "Corals and Coral Islands," represent one of these delicately-branching species; the first figure being the natural size, the second a portion of the same much enlarged, which shows that the branches are made up of minute cells. From each cell, when alive, the Bryozoan extends a circlet of tentacles less than a twelfth of an inch in diameter.

The third figure is a magnified representation of one of the incrusting kinds common to all seas, the crust being often

Fig. 50.—Nos. 1 and 2. *Hornera Lichenoides.* 3. *Discopora Skenei.* (Smitt.)

thinner than paper. From the orifices seen at the top of each little dome the Bryozoan expands its delicate tentacles like a beautiful flower.

The next coral-formers are the HYDROIDS, which, as I have before said, are related to the Hydra, a little fresh-water animal often found under the surface of a floating leaf, and seldom more than a quarter of an inch in length. It has the form of a polyp with long slender tentacles, and besides these tentacles, with their *lasso* cells, it has no special organs except a mouth and tubular stomach.

Like the fabled Hydra, if its head be cut off, another will

grow out; or if you cut off a foot, soon another will appear. And, more extraordinary still, if you cut a piece from it without either foot or head, in a short time this portion will become a perfect animal with both a head and foot. This re-supply of special parts of the body is truly wonderful, and almost beyond our comprehension. It is not, however, confined to the Hydra, for crabs, lobsters, and other crustaceans can reproduce a leg or a claw, if by accident they lose either; yea, more, if a claw should get injured so as to be useless, a crab has been known to become its own surgeon, and to throw off the broken limb from the next joint, from which a new claw or leg would spring.

What is somewhat analogous to this in ourselves is the secretion of fresh material to mend a broken bone; but unfortunately we cannot reproduce either a head or an arm, nor indeed brains, if we are deprived of any of them by accident or otherwise.

Fig. 51.—Hydra.

It is only animals of the lowest type that are thus privileged. Fig. 51 is a representation of a Hydra seizing its prey in one or two of its long arms, and there seems to be no doubt that it has the power of stinging them as it grasps them; for worms and annelids die immediately they are enfolded by one of the long tentacles, but tiny crustaceans frequently escape from their grasp unharmed, as their shells protect them from the sting of the Hydra's long arms.

This Hydra is the type of a large group of species, some of which multiply by buds which are persistent, and therefore increase almost indefinitely, making membranous coralla of considerable size, and often of much beauty.

Fig. 52 is an illustration of one. Its scientific name is *Hydrallmania Falcata,* but it is also called *Plumularia,* in allusion

Fig. 52.—*Hydrallmania Falcata.*

to its delicate plumes, which somewhat resemble the leaves *of a graceful* fern.

All along its branches there are minute cells, each of which was the seat of one of the little Hydra-like animals with short tentacles star-like in form.

But I must now notice the more important CORAL-REEF tribes which have built up islands, and I had almost said continents, for millions of years past. Some of these structures are in the form of atolls—that is, islands with large lakes or lagoons in their centres. Others are level, and covered with verdure for many square miles; the Radach group, for instance, being 520 miles in length and 240 broad, containing about 132,800 square miles. Others, again, are in the form of vast reefs, which act as barriers; those on the coast of Australia extending nearly 1,000 miles.

Darwin, in his excellent work on this subject, speaks of the insignificance of all human structures compared with these mountains of stone, accumulated by the agency of various minute and tender animals, and which Montgomery has thus beautifully described:—

"Compared with this amazing edifice,
Raised by the weakest creatures in existence,
What are the works of intellectual man?
Towers, temples, palaces, and sepulchres,
In honour of the living and the dead,
What are they?—fine-wrought miniatures of art,
Dust in the balance, atoms in the gale,
Compared with these achievements in the deep,
Were all the monuments of olden time,
In days when there were giants on the earth.
Babel's stupendous folly, though it aimed
To scale heaven's battlements, was but a toy,
The plaything of a world in infancy—
The ramparts, towers, and gates of Babylon,
Built for eternity; though where they stood,
Ruin itself stands still for lack of work,
And Desolation keeps unbroken sabbath—
Great Babylon, in its full moon of empire,
Even when its 'head of gold' was smitten off,
And from a monarch changed into a brute—
Great Babylon was like a wreath of sand
Left by one tide and cancelled by the next.

Egypt's dread wonders, still defying Time—
Egypt's grey piles of hieroglyphic grandeur—
Her Pyramids would be mere pinnacles,
Her giant statues, wrought from rock of granite,
But puny ornaments for such a pile
As this stupendous mound of catacombs
Fill'd with dry mummies of the builder worms."

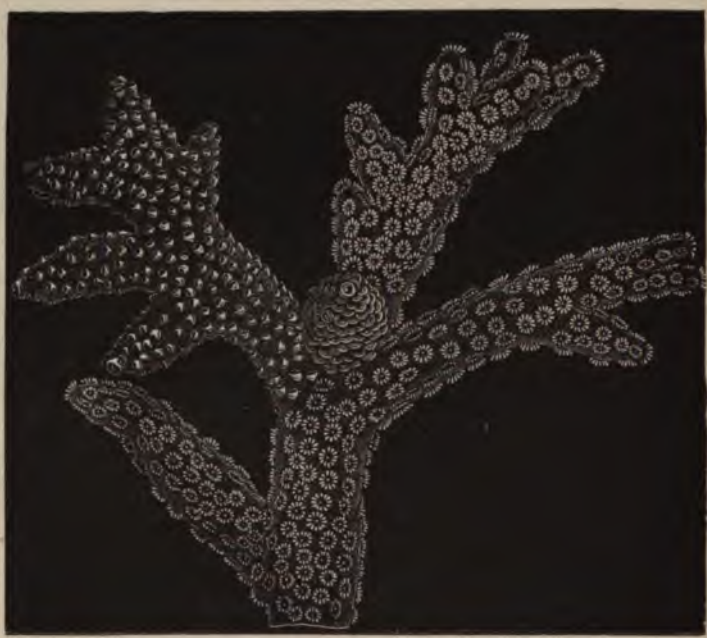


Fig. 53.—*Madrepora Aspera.*

Before I further describe the work of these marvellous little creatures, I will give you a specimen (Fig. 53) of a madrepore of beautiful form, something like a tree, and yet it is filled with animal life, each of the little stars being a mouth to take in both its food and its coral-producing material. Many varieties of these madrepores may be found on and near the coral islands, in all their loveliness; for not only are the forms of the coral very beautiful, but the animals *themselves* exhibit all the tints of the rainbow.

And here I must notice a point especially relating to the object of this work, and giving further evidence of the absence of climatic temperatures in the early stages of the world's history. Judging again of the past by what we can learn of the present, we find that it is only in the warmer regions that these corals work. The seas where they now live and thrive are never colder than 68° Fahr., and the surface waters reach the high temperature of 86° Fahr. in the Pacific, and 83° Fahr. in the Atlantic. Therefore we may come to the conclusion that the waters in which the ancient corals lived were as warm as this; and if so, then, as coral limestone is found from one pole to the other, it seems pretty clear that the seas and oceans were universally of a high temperature, and that therefore not until after the Carboniferous period were there varieties of climate, nor until the Sun and Moon were appointed for signs and for seasons, as described in the last chapter.

In connection with the gradual upheavals and subsidences of the Earth's crust, to which I have so often alluded, these coral islands also tell an interesting story.

We find that Darwin, who traversed the Pacific with Captain Fitzroy, R.N., gives twenty fathoms as the greatest depth at which these island-builders can live; and yet some of the Fiji reefs are 2,000 feet in thickness. The little animals must therefore have built up their pile near to the water's edge, and then the bottom of the sea must have subsided as gradually as the corals went on building. Supposing this subsidence to have been at the same rate as we find it now in certain districts—viz., a foot in a century—twenty thousand years were required to form this Fiji reef.

Of the atolls I must say a little more; and Plate X. will help you to understand their formation. You will see that a rim of coral rock encloses a large lagoon. The corals, instead of forming a reef extending in a straight line, have

X.—A Coral Atoll.

constructed it in a circle or some irregular shape, with the walls meeting, or nearly so, thus enclosing a portion of the sea. These reefs are often covered with foliage, as in our illustration. Some of the lagoons are shallow, and the corals can be seen on their bottoms and sides through the clear water.

All along I have spoken of the work of these polyps, and some poets have dwelt largely upon their toil, as though they formed this coral something like the bees do their cells; this, however, is not the case. The coral rock bears the same relation to the polyp that the shell does to the snail or the oyster; and the material is secreted without any more effort on the part of the tiny animal than we make to produce our bones—that is, by eating suitable food to form the proper secretion. And yet it may, I think, with propriety be called work; for though the creatures do not exert themselves specially to produce the rock, God works by their means.

"Millions of millions thus, from age to age,
Laid line on line on terrace spread,
To swell the heightening, brightening, gradual mound,
By marvellous structure climbing towards the day.
Each wrought alone, yet all together wrought,
Unconscious, not unworthy, instruments,
By which a hand invisible was rearing
A new creation in the secret deep.
Omnipotence wrought in them, with them, by them;
Hence what Omnipotence alone could do
Worms did. I saw the living pile ascend,
The mausoleum of its architects,
Still dying upwards as their labours closed;
Slime the material, but the slime was turn'd
To adamant by their petrific touch;
Frail were their frames and limited their lives,
Their masonry imperishable. All
Life's needful functions, food, exertion, rest,
By nice economy of Providence
Were overruled to carry on the process
Which out of water brought forth solid rock."

I have altered a few words in these charming lines from Montgomery's "Pelican Island" to agree with our present

knowledge of these coral-makers. I think the ladies will be pleased with a representation (Fig. 54) of the lovely animal which forms the red coral they so admire: this kind is principally found in the Mediterranean Sea or its islands, some-

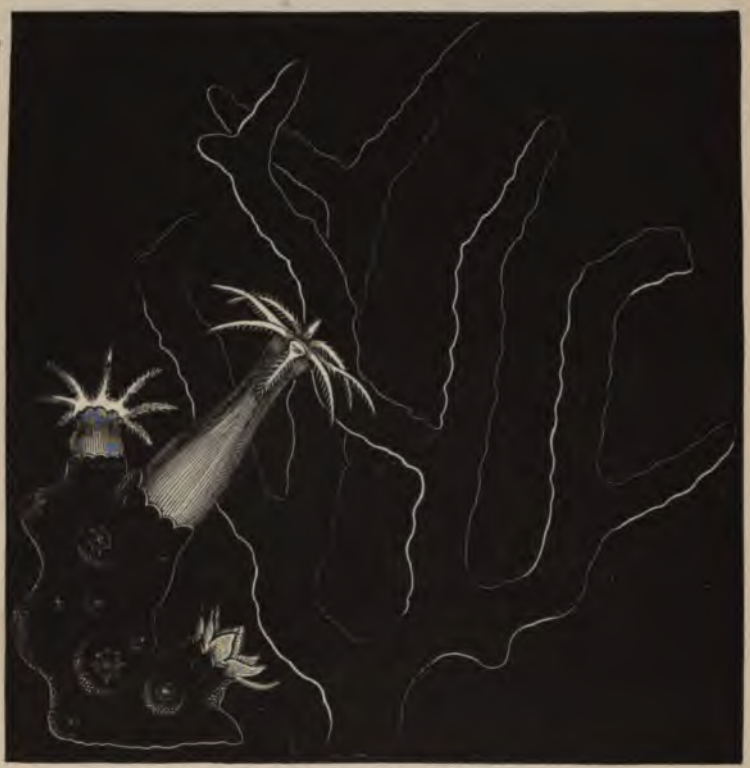


Fig. 54.—*Corallium Rubrum.*

times as much as 80,000 pounds weight of this precious coral being obtained in one year. The rose-coloured is the most highly valued, because it is the most rare. So deeply interesting are these coral-builders and their marvellous works, that I feel quite loth to leave them, but I must do so for the *present.*

As I am now writing a chapter upon the fauna of all ages, I shall doubtless be expected to say something about

THE ORIGIN OF SPECIES.

But before I do so, suffer me to repeat again what I have often stated in my lectures, that though I differ on some points from the eminent men who teach the doctrine of Natural Selection, and who tell us that all the varieties of animal life, including man himself, have descended from one common origin, yet I feel that we owe those philosophers much gratitude for having studied Nature so carefully that they have put us in possession of innumerable facts that are not only deeply interesting, but are also of the highest importance. For, besides being benefited by these researches, we have also been stimulated to greater exertions in the investigation of the laws of the Universe, ordained with so much forethought and evident design by the infinitely wise Creator.

The names of Darwin, Huxley, Hooker, Tyndall, and others will be very long remembered, for having revealed to the world an amount of knowledge respecting both the fauna and flora, and the various laws relating to physical phenomena, which, but for their devoted study of Nature, we might never have possessed.

In differing, then, from men of such intellectual mark, possessing such high scientific attainments, I do so with all respect; for, to my mind, it would be equally wonderful, and would as much require an infinite Deity, to develop all the varied forms of organic life from a single germ as to call them into existence by special acts of creation.

Let me impress upon my readers that I most thoroughly believe in so much of the Development theory as implies a progression of species from a lower to a higher organic condition; for this is evidently part of the Divine plan. Our Mammalia are certainly a very long way in advance of

the Saurians which roamed over the Earth in its earlier stages, and that, not only in structure, but also in sagacity and instinct. Equally so are our trees and flowers of a higher class than those of the Carboniferous and previous periods.

It must also be admitted that both animals and vegetables are capable of still greater improvement by cultivation. Some philosophers have founded upon this the doctrines of "Natural Selection," "The Survival of the Fittest," "Development by Use," "Variation," and all the other things claimed by the Evolutionists.

"Natural Selection," or "The Survival of the Fittest" in the "Struggle for Existence," is certainly also a law; otherwise we should see many more malformed and impotent individuals, both amongst animals and men, whereas their proportion is so small that they may be quite considered as exceptions. "Development by Use" of limbs and organs is also a law; otherwise, all athletic exercises, which so improve and develop our bodies, would be utterly useless. Still, I cannot think that the non-use of any particular organ or limb would eventually cause its entire absence.

I believe, therefore, that the birds whose skeletons have been found on isolated islands without even incipient bones of wings, were so created for some wise purpose.

The late Robert Knox, a man of great genius and knowledge, speaking upon the congenital transmission of acquired peculiarities of structure, says:—

"No deviations in form, even when they are produced, can ever become congenital or hereditary. Let the Chinese foot bear witness to this fact. For thousands of years has this non-progressive race been endeavouring to destroy the foot of Chinese women without any success further than the modification of the individual.

"'Naturam expellas furcâ, Tamen usque recurret,' is the pithy and true saying of Horace, verified from all antiquity."

And now, with regard to "Variation"—one of the most interesting of these doctrines—I would say that I believe the numerous varieties of dogs, from the tiny dwarf terrier to the Newfoundland and mastiff, had a dog in some form for their ancestor.

In like manner, the parent tree of all the varieties of apples was essentially an apple-tree, though perhaps far inferior, from the want of that cultivation which improves every species, and which I have noticed before as being one of the Divine laws which God has entrusted to man to carry out. Without the law of variation, in all probability there would have been but one kind of dog, but one kind of pigeon, but one kind of horse, and also but one sort of apple, one sort of plum, one sort of grape. The endless varieties of flowers also would have fallen far short of what they now amount to.

And as the carrying out of this law of variation is so much in the hands of man, agricultural and horticultural societies are, I think, fulfilling the Divine plan by bestowing rewards on those who produce more perfect kinds of corn and cattle, fruits and flowers.

To man also pertains the still further power of obtaining endless varieties of form, size, and colour in the animal and vegetable kingdoms, quite apart from quality; and this is almost as important and beneficial to us all. For the love of variety has been implanted in us by our Creator, who abundantly gratifies it; for each grain of sand amongst the countless numbers upon the sea-shore, each leaf amongst the millions waving in the forest, and each star amongst the myriads which bespangle our evening sky, each, each and all differ from the rest.

Does not God himself delight in forming all these infinite combinations? Did He not, when surveying all these outcomes of His wisdom and power, proclaim them to be all very good?

It will be seen, therefore, by what I have said, that I am favourable to some things taught by the Darwinian school; but there are others which I cannot agree with. To me Nature and Revelation both teach a special creation of individual species, each "after his kind;" and I will give some of my reasons for thinking so, leaving my readers to form their own opinions.

We find that all the various strata from the Cambrian upwards abound with numerous specimens of animals and vegetables which lived and died during all the past ages of the world, furnishing us thereby with the history of its condition during every stage of its advancement. Surely this must have been one of the many providential arrangements to reveal to us the "story of His handiwork."

It is not as if a few shells and bones were scattered here and there, after collecting which we might come to very wrong conclusions as to the original form and modes of life of the creatures to which they belonged; but whole animals, from the enormous Ichthyosaurus down to the minute monad, have been preserved intact, to teach us their outward form and structure, also their soft internal organs, and even their undigested food has sometimes been turned to stone to tell us how they lived. Yea, more, their very eyes have been changed to adamant, in order that we might know how marvellously beautiful and how delicately constructed a nervous system must have existed in animals that possessed such perfect optical organs.

It was whilst examining the eyes of a

TRILOBITE,

some years ago, that I was deeply impressed with these thoughts. I can scarcely describe my sensations when I took into my hands the little petrified creature (Fig. 55), which *had prob*ably lived millions upon millions of years ago; and

when I noticed, through a magnifying-glass, that its thousand eyes were still perfect, and that every facet was there, I read another important story from their preservation, which was this:—That every one of those facets must have had a nerve attached to it, and those nerves must have all passed into a brain; therefore, as early in the Earth's history as the Cambrian strata, animal life existed endowed with a delicate nervous system.

Before I say more, please to look at the figure of this crustacean, and notice the enlarged view of one group of its eyes (Fig. 56*a*). See also how prominently the two groups are placed upon its head, so as to give it an extensive range of vision. *b* is a few of these eyes still more magnified.

Now let us notice the eyes of a bee. Æons upon æons of years have rolled away, and still a similar form of eye is in existence. You will see in Fig. 57 how these numerous facets are placed in two groups, and that they are hexagonal in form, in order that they may be packed closely together without any space being lost by interstices. Then by dissection may be seen the tiny nerves passing down from the cornea to the optic nerve. And judging from the eye of the bee how the nerves of compound eyes are arranged, we must conclude that the Trilobite had a similar disposition of them.

Often have I asked geologists holding the opinions of the Darwinian school to explain to me how it came about that in the earliest and lowest strata where organic remains are found there should be an animal with so perfect a nervous system, and none of the infinite gradations existing which, by the evolution theory, would be required to produce it. The answer I have generally received has been that all those gradations *may have* existed in the previous Huronian or Laurentian rocks!

Mr. Etheridge, in his Presidential Address to the Geological Society in February, 1881, speaks of the fossils

Fig. 55.—Trilobite (*Asaphus caudatus*).

Fig. 56.—Eyes of a Trilobite.

Fig. 57.—The Head and Eyes of a Bee (Magnified).

from the Lower Cambrian of South Wales—Trilobites, Brachiopods, and others—and says, "I particularly mention this first assemblage of life, as being, so far as I know, the earliest in the Earth's history on record, and it consists, nevertheless, of forms whose organisation was not embryonic." I must ask then to be shown decided specimens of all such gradual mutations and evolutions, from the lowest and least complex form of nerve-structure affording the sense of sight, up to the elaborate eye of the Trilobite.

Please do not understand me to say that the structures of the eye of the bee and of the Trilobite are identically the same. Far from it; I am only speaking of the nervous system we find connected with such groups of eyes, which exist also in the present Crustaceans. The bee lives in the air in bright sunshine, whereas the Trilobite lived in water; and in consequence of the dense vapours which then surrounded the Earth, the light enjoyed by this little Crustacean would be comparatively small; and yet this dim light was doubtless provided for by a suitable structure of the numerous lenses; for do we not find that the bat and the owl see best during the shades of evening, whereas the squirrel and the lark rejoice in the sunshine? Does not the lynx leave its lair at night-time to seize its prey, whilst the eagle soars upwards towards the Sun, looking that glorious luminary full in the face? and yet the eyes of these animals with such diverse capabilities have a similar arrangement of nerves, the difference being in the form of the cornea, iris, or crystalline lens, or in some mechanical arrangement of muscles for moderating or increasing the reception of rays of light, thus giving the one the same amount of vision in the twilight which the other enjoys only in broad daylight.

There are insects with many more eyes than the Trilobite. In a species of beetle called the Mordella, 25,000 eyes have been counted; in a dragon-fly, 12,500; and even our common

house-fly has 4,000. I shall doubtless be asked how it can be ascertained that each of these facets gives a separate image of the object. This is easily answered. I have amongst my microscopic specimens a group of eyes taken from a small beetle; and although there are no less than one thousand facets in this group, the whole of them together do not equal the half of a small pin's head in size. By putting this group under a high power, then fixing into the diaphragm-box a card with a letter cut out of it, the light will pass through the perforated card, and a perfect letter will be seen in every facet. When I first succeeded in this experiment, and saw the thousand sparkling letters, I was intensely pleased, and thought it one of the prettiest sights I had ever witnessed.

It must be understood, however, that objects are not thus multiplied to the insect or crustacean any more than objects are doubled with our two eyes. But as all the minute nerves meet, the effect is a greater range of vision, doubtless adapted to the creature's wants. Thus is there an infinite amount of marvellous design and beauty even in the organs of an insect which we crush without a thought.

But to return to our Trilobite. I called your attention in Fig. 56 to the groups of eyes being raised above the head, the form of each being the frustum of a cone. Here we notice a special adaptability to its circumstances. Destined to live at the bottom of the ocean, it only required to see in a horizontal direction, and it had the most perfect contrivance for doing so.

In this one animal there was also a great variety; for some had 400 eyes, and others 6,000. In the Cambrian and Silurian beds of Britain the number of species amounted to nearly 300, the Caradoc and Bala beds alone having 123 species; and so numerous are they that whole rocks are formed of their remains. They are not found in the Old Red Sandstone, this being perhaps a fresh-water deposit; they are

not very common in the Devonian rocks of Britain, and they seem to have disappeared for ever from creation after the Carboniferous Limestone had been deposited. Hugh Miller says, in reference to this:—"The Omnipotent Creator, infinite in His resources, in at least the details of His workings seems never yet to have repeated Himself, but rather, as Lyell expresses it, breaks, when the parents of a species have been moulded, the die in which they were cast."

I must beg you to notice that only three out of the four great divisions of the animal kingdom have been found in the earliest strata—namely, the Radiata, the Articulata, and the Mollusca. The vertebrates did not appear till the time of the highest Silurian beds (Ludlow), in which was found the oldest known fish—the Pteraspis; and mark the fact, that no less developed or embryonic forms of such vertebrates have been discovered.

There was no direct evidence to confute my friends who said that the various gradations leading up to the Trilobite might have existed in the Laurentian strata and been utterly destroyed. But what can be said now of the sudden appearance of a perfect vertebrate in the Upper Silurian, notwithstanding the Cambrian and Lower Silurian abound with animal remains? Indeed, there can be only one reply—the "*may be*" will serve no longer. Either the gradations must be pointed out amongst the innumerable fossils, or a special creation of a new species must be admitted.

Agassiz did very much for natural history by re-classifying fishes. First, he formed an order which he called *Placoids* (from πλάξ, *a broad plate*), which, having an internal cartilaginous skeleton, were covered externally with armature plates and points of bone. Next, he called *Ganoids* (from γάνος, *splendour*, referring to the brilliant surface of their enamels) all those fishes, of whatever consistency their skeletons, which are covered by a continuous, or nearly

continuous, armour of enamelled bone, or by great bony plates that lock into each other at their edges, as in the Sturgeon. Thirdly, he placed in an order he called *Ctenoid* (from κτείς, *a comb*) those fishes covered with scales of a horny substance and pectinated at their lower edges, like the teeth of a comb, as in the Perch. And lastly, fishes whose scales, like those of the Salmon, are defined all round by a simple continuous margin, he named *Cycloids* (from κύκλος, *a circle*).

The earliest fishes—firstborn of their family—says Hugh Miller, seem to have been Placoids, and the Silurian has not yet afforded traces of any other vertebrate animal.

With the Old Red Sandstone the Ganoids were ushered upon the scene in amazing abundance; and for untold ages, comprising mayhap millions of years, the entire ichthyic class consisted, so far as it is yet known, of but these two orders. For during the times of the Old Red Sandstone, of the Carboniferous, of the Permian, of the Triassic, and of the Oolitic systems, all fishes, though apparently as numerous individually as they are now, were comprised in the Ganoidal and Placoidal orders.

It is interesting to notice that the period of these orders seems to have been nearly correspondent with the reign in the vegetable kingdom of the Acrogens and Gymnogens, and the intermediate classes their allies. At length, during the ages of the Chalk, the Cycloids and Ctenoids first appeared and were gradually developed in creation, until the human period, in which they seem to have reached their culminating point, and they now many times exceed in number and importance all other fishes.

We do not often see a Sturgeon (our British representative of the Ganoids); and though the Skate and Dog-fish (our representatives of the Placoids) are much less rare, their number bears but a small proportion to that of the fishes

belonging to the two prevailing orders, of which thousands of boat-loads are landed on our coasts.

It was in the Old Red Sandstone that the Placoids and Ganoids appeared, which, as I have stated, were encased more or less in defensive armour composed of enamelled plates, instead of the horny scales which cover the fishes of recent times. The following engraving (Fig. 58) will give some idea

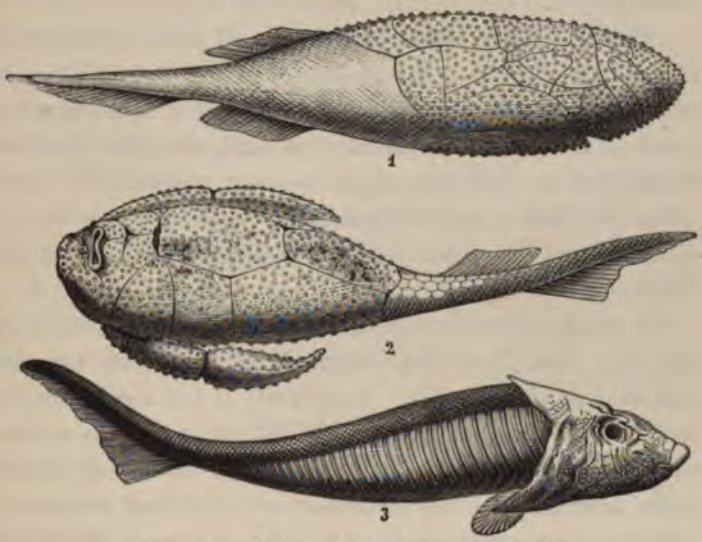


Fig. 58. — Fishes of the Devonian Epoch.
1. Coccosteus. 2. Pterichthys. 3. Cephalaspis.

of their form, and it will be noticed that the *Cephalaspis* has considerable outward resemblance to some fishes of the present time.

It is a well-known fact that fish can sustain a higher degree of temperature than any other animal, from their being found in hot springs in different parts of the world, where no other form of organic life could exist. In connection with and in confirmation of this hypothesis, Hugh Miller, in his "Old Red Sandstone," has observed that about

the time of the disappearance of this ancient race of fishes, we have the earliest indications of the commencement of the alternations of summer heat and winter cold in the appearance of annual rings in the fossil trees. His words are :—

"Just as winter began to take its place among the seasons, the fish, fitted for a highly-heated medium, disappeared; they were created to inhabit a thermal ocean, and died away as it cooled down."

That the construction of the Placoid and Ganoid fishes adapted them for the thermal waters of the Old Red Sandstone period is another evidence in favour of my argument that the seasons did not commence until after the Carboniferous period; and thus again geology confirms the order given by Moses, and evidence after evidence turns up to establish and strengthen our faith in the truthfulness of our Bible.

A word or two more about the Pterichthys (No. 2, Fig. 58), first found by Hugh Miller with its fore-fins extended at right angles. Apparently it had died instantly and in much fright: this would indicate that some sudden catastrophe had overtaken it; and as thousands of square miles now form a vast mausoleum of countless swarms of ocean-dwellers, which once gay with life sported in the waters and were evidently also destroyed in a moment, we may perhaps infer that some sudden volcanic eruption beneath the waters must have poisoned them at once.

That this sudden destruction of fish still sometimes takes place is evident; for on Friday, the 6th of December, 1789, Captain Stewart, with the ship *Brothers*, arrived at Leith from Archangel, and reported that on the coast of Lapland and Norway he sailed many leagues through immense quantities of dead haddocks floating on the water, and he had spoken many ships who reported the same fact. It may be *that sulphuretted* hydrogen was suddenly injected into the

sea from some submarine volcano; this would quite account for such a destruction of the finny tribe.

There is another fish, also discovered by Hugh Miller, of very great importance in these strata, called the Asterolepis, which was of enormous size, sometimes attaining the length of twenty or thirty feet. It was clothed with strong bony armour embossed with star-like tubercles, hence its name; but it had a cartilaginous skeleton. The mouth was furnished with two rows of teeth; the outer ones small and fish-like, the inner larger, with reptilian character.

Now, Hugh Miller very properly asks the Evolutionists for the various gradations of this mighty Ganoid from lower types of life, for they are nowhere to be found; and yet we have the range of strata teeming with animal formations of millions of years in which to seek them. He therefore replies for them, and says—"In the morning it was not, and in the evening it was." Another proof this of each species being *created*, not evolved, after its kind.

The Permian System.

At the close of the Carboniferous formations violent disturbances appear to have broken up and dislocated the coal-beds to a vast extent; and on the denuded edges of these distorted masses another system of sedimentary rocks was deposited. This system has been denominated the Permian, from the fact of its being developed under favourable circumstances in that part of Russia which was at one time the ancient kingdom of Permia.

It consists of different series of strata, which, according to Sir Roderick Murchison, constitute one natural mass. These strata are the Magnesian Limestone, Red Sandstone, and Marls. The fossil remains are much fewer, and, generally speaking, are a continuation of those of the preceding period, with some exceptions. Most of them include the great body

of the ancient Placoid and Ganoid fishes of the Old Red Sandstone; and here I must notice that the heterocercal tail, which characterises the fish of the earlier periods of the Earth's history, ceases to predominate. Here, too, my little friend the Trilobite, which has accompanied us as a leading and important member of the creation from its dawn, disappears from existence, and is no more found on our planet as a living organism.

I do not intend to say much of this series, but I will just notice the Magnesian Limestone, which is in some places 450 feet in thickness. This stone is much used for building purposes, and has been largely used in the construction of some of our finest edifices, as York Minster and Westminster Hall, which have stood for so many centuries. The New Houses of Parliament also are built of it; but in a few parts they are showing signs of early decay, from some oversight in the selection of those particular stones.

With the Permian rocks we reach the close of what is called the Palæozoic period. The Triassic strata, which next succeed, are the base of the

Secondary Rocks,

in which Gypsum, or Alabaster, is found, and in masses large enough to be used in architecture. Some of my readers may remember my showing them in the Assyrian Galleries of the British Museum the carved slabs of this material, and the two large winged-bulls each cut out of one solid block of alabaster weighing ten tons. In Triassic districts, clays, shales, and soft sandstones predominate, and give rise to broad level expanses, rather tame and uninteresting in their superficial features, and never rising to elevations above 800 feet.

In these strata there are a large number of entirely new species. Sir Charles Lyell states that in the Austrian Alps *alone*, out of forty-nine genera of fossil molluscs found in the

Triassic beds, only eleven of them are found in the previous rocks. And many of the genera which had previously existed, now entirely disappeared.

In these seas the Ammonite (Fig. 59) seems to have taken the place of the Trilobite in number and variety; with the great difference, however, that the latter lived at the bottom of the ocean, whereas the Ammonite, it is supposed, moved freely in it, and sometimes floated at the top of the waters. This large family runs through all the fossiliferous forma-

Fig. 59.—Perfect Ammonite.

tions from the Trias to the Chalk, in which latter period it became extinct.

The name is derived from a fancied resemblance of the shell to the sculptured horn on the head of Jupiter Ammon. They were the *lusus naturæ* of the learned, the petrified rams' horns of the vulgar, and snakes decapitated and turned into stone by the prayers of St. Hilda, as the superstitious folks at Whitby believed; whereas, in the South, the country people of Bath and Bristol represent St. Keyma surrounded with serpents, which she is changing into headless stones by the fervour of her devotions.

Some forms of these animals are very beautiful, especially a genus closely allied to the Ammonite, called *Ceratites*

nodosus, and found in the Muschelkalk (Fig. 60). The shells of Ammonites are of various sizes, from half an inch in diameter to four feet. Large numbers are found at Whitby and Lyme Regis. They also occur at a great elevation on the Maritime Alps, showing that those mountains must have been heaved up after the formation of these strata. Yea, more, even at the height of 16,000 feet (that is, three miles) up the Himalaya Mountains these animals are found, thus telling us the story of those wonderful upheavals which formed the mountains in the various ages of the world's history.

Please to look at our Ammonite floating on the top of the sea (Fig. 61). What a graceful, beautiful creature it is! and not very much unlike the Nautilus of our times.

It had a membrane passing through all the chambers, which it is probable it could empty or fill with water at pleasure, so as to be able to float or sink according to its inclination, as the Nautilus does. Notice also how well its arched form would enable it to bear the excessive pressure of superincumbent waters when at the bottom of the sea. Does not this show the existence of a wisely designing First Cause? And has not the skilful architect of the groined roof of a splendid cathedral, or the designer of a noble bridge, only imitated the models he has seen in Nature?

At this period there existed another family of Mollusca in great abundance, called Belemnites, from the Greek word *βέλεμνον* (*a dart*), on account of their supposed resemblance to the head of a javelin (Fig. 62). The ancients called them *Idæi dactyli*, from their being found on Mount Ida, and from their resemblance to fingers. Some of the Northern nations, whose imagination was of a glowing cast, called them "devil's fingers" and "spectre candles." Others again named them "thunder stones," for, before their animal origin was suspected, they were supposed to be concretions produced by electricity.

Fig. 60.—*Ceratites nodosus* (Muschelkalk).

Fig. 61.—Ammonite (restored).

Fig. 62.—*Belemnites acutus.*

Quite as much as the Ammonite do they illustrate my argument in reference to the increased fecundity of the waters at this period; for there are millions of individuals, and between eighty and ninety species of these Belemnites. They are supposed to have swarmed near to the bottom of the sea, and to have seized their prey from below. (Fig. 63 is a supposed restoration.) Like the Ammonites, they were cephalopods—that is, having organs of motion round about their heads; and they vary from a very small size to the length of a foot, and several inches in circumference.

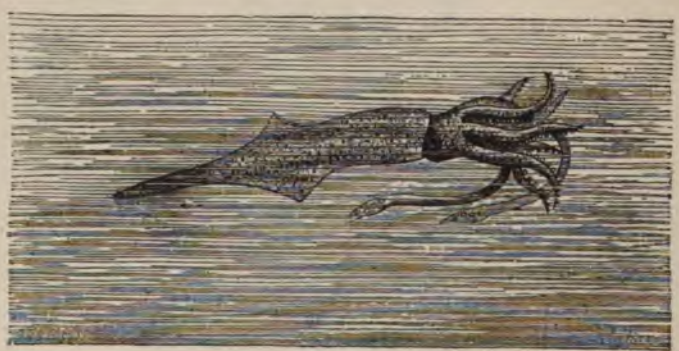


Fig. 63.—Belemnite (restored).

It has also been found that, like the Sepia, they were supplied with an ink-bag to darken the water, and so hide themselves from their enemies; for specimens have been found in Lyme Regis with this ink-bag and its contents perfectly preserved, from which a sepia drawing has been made. Dr. Buckland infers from this circumstance that the animals must have died suddenly; for their living analogues eject the inky fluid upon the least approach of danger, and they must therefore have been overwhelmed in a moment by some catastrophe. I look upon this, however, as a part of the Divine plan to preserve for us intact these animals to illustrate the leaves of Nature's volume.

The Advent of Birds.

"And fowl that may fly above the earth."

We now come to another most important circumstance. Thousands, yea, perhaps millions, of years have passed since the Trilobite lived in the primeval ocean; and millions upon millions of animals have been discovered in all the different strata, but no trace of birds. Now, however, in the New Red Sandstone of the Trias, footprints of birds are found, apparently belonging to the tribe of Waders—and, if so, to a highly-organised class of vertebrated animals.

Professor Hitchcock brought before the attention of European *savants* some very distinct tracks in the New Red Sandstone of the Connecticut valley, first observed by Dr. Deane of Greenfield, who immediately noticed their similarity to the impressions left on the muddy banks of the river by the living aquatic birds common to the locality. Subsequent examinations discovered similar footmarks in various quarries in the same valley, and in other parts of Massachusetts; and several specimens are now in the British Museum, the most remarkable of which is a slab eight feet by six, which exhibits traces of various sizes and belonging to different individual birds. Fig. 64 is a representation of this slab.

Some of these footprints are of small birds, and the others are those of birds of enormous size, indicating proportions equal nearly to twice the magnitude of the ostrich. In one species (*Ornithichnites giganteus*) the imprint of the foot measures fifteen inches in length and ten inches in width, excluding the hind claw, which is two inches long. The distance of the impressions from each other varies from four to six feet: the former may be taken as the length of the stride of the bird when walking at an ordinary pace, and the latter when proceeding more swiftly.

These dimensions, so far surpassing those belonging to any known birds, led many geologists to conceive that some mistake had been made respecting the nature of the impres-

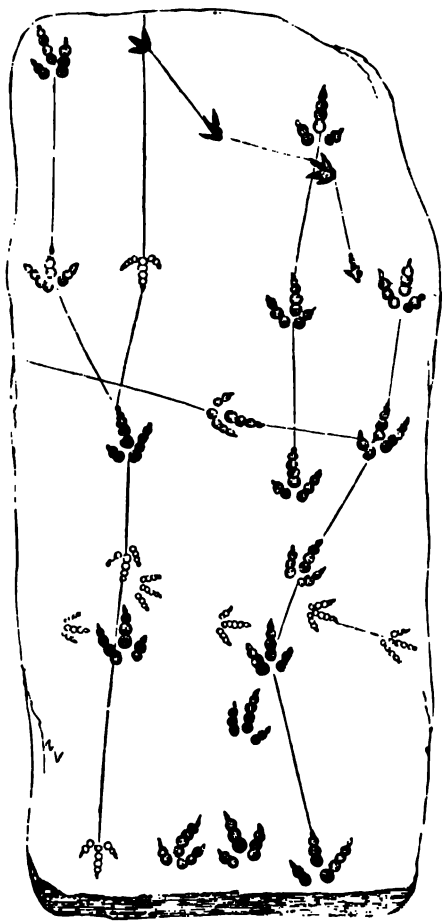


Fig. 64.—Portion of a Slab of New Red Sandstone from Turner's Falls, Massachusetts, with imprints of footsteps of a large bird.

sions, till convinced by an actual inspection of the specimens transmitted to Europe, and by the discovery of the bones of

a very large bird only recently extinct in New Zealand, far exceeding the ostrich in size.

According to Professor Hitchcock, there have been detected in these rocks the footprints of no less than thirty-two species of bipeds, thirty of which are believed to have been birds. The tracks have been found in more than twenty places, scattered through an extent of nearly eighty miles from north to south ; and they are repeated through a succession of beds attaining at some points a thickness of more than 1,000 feet, and were probably thousands of years forming.

Lyell says that when he visited the United States in 1842 he found Professor Hitchcock had observed 2,000 impressions; and all of them were indented on the upper surface of the layers, whilst the corresponding casts standing out in relief were always on the lower surfaces or planes of the strata.

In one specimen found at Turner's Falls on the Connecticut, by Dr. Deane, the impression of the integument or skin of the foot has been found, and has been recognised by Professor Owen as resembling the skin of the ostrich. This is as interesting as it is remarkable, and seems to settle the question of the footprints being those of birds and not of reptiles.

Dr. Dana too, by an ingenious argument in reference to the analysis of the numerous coprolites that are also found, says that the proportion they contain of uric acid, phosphate of lime, carbonate of lime, and organic matter, shows that they resemble guano which is produced by birds.

What I wish, then, especially to call the attention of my readers to is this, that birds are mentioned in their right order as preceding the sea-monsters—

"*Let the waters bring forth abundantly the moving creature that hath life, and fowl that may fly above the earth in the open firmament of heaven. And God created whales.*"

And I can find no evidence whatever that birds existed in or before the Carboniferous period. In none of the fine trees of that epoch can it be seen that birds built their nests. The tall Sigillariæ, the gigantic Calamites, and the thick bushy ferns, had none of those varied and beautiful forms of life

Fig. 65.—Bird (*Archæopteryx*) found in a Lithographic Stone.

fluttering about them, and imparting the additional charm they now lend to our forests.

In like manner in all the preceding strata no traces whatever are found of birds. I must, therefore, contend most strongly for the authenticity and correctness of Moses' *account.* Whether the series of evolutions necessary to

produce a bird from an animal of a lower type were now completed, and thirty species of all sizes took up their place amongst the denizens of the Earth, or whether they were now for the first time created, my argument equally holds good—That the order of the event as given by Moses is wonderfully and remarkably exact.

It has struck me as possible that one cause of so few actual remains of birds being hitherto discovered in the same strata with these footprints, is that they could, by flying, more readily escape from dangers and catastrophes which overwhelmed and buried up other animals living on the land, and would, therefore, generally die natural deaths; their bones would be thus scattered and crumbled by exposure to the elements, and would have little chance of being preserved in the sediment at the sea-bottom.

Later on, however, in the Upper Oolite, in the lithographic stone quarries of Solenhofen, in 1862, was found the remains of a bird (*Archæopteryx*), with its feet and wings, and some of its feathers. It was about the size of a rook; and Professor Owen says it was not, as some imagine, an intermediate animal between a bird and a reptile, but a true bird, though it differs remarkably from all known birds in having two free claws belonging to the wing, and also in the structure of its tail.

This valuable specimen, of which I give a representation on the opposite page (Fig. 65), may be seen in the Natural History branch of our British Museum at South Kensington, which I strongly advise all my readers to take an early opportunity of visiting; for there they will find many of the fossil remains of the very animals I am describing, arranged with the utmost care and judgment by Dr. Henry Woodward.

The Advent of Sea-Monsters.

"And God created great whales."

It is pretty certain that Moses knew nothing of the Cetaceans of our polar regions, as he had never seen any other than the Mediterranean and Red Seas. He would therefore describe the enormous Saurians of this vision as sea-monsters (תַּנִּינִם *tanninim*), and it is not improbable that he actually saw them sporting in the deep.*

I have shown that it is in the Trias we first find traces of birds; and now in the Lias suddenly we come upon these huge habitants of the ocean, amongst the most important of which are the Ichthyosaurus and Plesiosaurus—from ἰχθυς σαῦρος, *a fish lizard*, and πλησίος, *near*, and σαῦρος, *a lizard*.

Will my readers close their eyes for a few minutes, and imagine they are accompanying me to the shore of one of those ancient seas? Let us take our stand upon a rock overlooking the waters, and watch what is going on. Look at those beautiful Ammonites with their gracefully-curved shells floating on all parts of the surface; see how they are descending below the waters, then again rising without any perceptible effort, and seeming to thoroughly enjoy life. Notice those fishes of endless variety swimming in all directions. Look at that great black spot; it seems as though many gallons of ink had been poured on the sea. It is a large Belemnite surrounding itself with this opaque cloud, and hiding from its pursuer securely in its centre. Pray also observe that flying monster with wings like a huge bat, which in the place of a beak has dreadful jaws armed with numerous teeth; it is a Pterodactyle, and is pursuing that large Lepidotus; now it has dived down and caught its prey, and carrying the fish away to the shore, intends to devour *it at its leisure.*

* *For note upon* Jonah and the Whale see Appendix.

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XI.—Imaginary Fight between an Ichthyosaurus and a Plesiosaurus.

But see! what is that immense creature approaching? How it makes the very deep to boil! And now it raises itself out of the sea, and is sending up two jets of water from its blowers. Surely it must be a whale, and yet it does not look exactly like one; its head is more like that of a lizard, and its snout resembles that of a dolphin.

What a dreadful eye it has! it is as big as a man's head, and seems to flash fire. Really its glance is enough to petrify one. See what an enormously long tail it has, with its vertical fin enabling it to turn in all directions with ease and rapidity. Now it has dived down; but look! it has come up again. There it is, and a number of others also; it seems to breathe the air like our Cetacea, and therefore cannot keep long under water. How fast it is swimming with those large whale-like paddles! They are certainly more than a yard in length.

I had heard that this creature has thick long scales, which is evidently a mistake, for the whole surface of its body is as sleek and smooth as that of a porpoise. See! it is opening its awful jaws, which cannot be less than a fathom in length, and there must be hundreds of those horrible teeth. There! there! it has seized a young Ichthyosaurus, and I declare it has swallowed it whole. What a cannibal, to feed upon its own species; and what a throat it must have, to have gorged down such a large creature! The young Saurian must feel very uncomfortable in the stomach of its relative, and Jonah's good fortune is not likely to await it.

But what is that long-necked monster sailing along, something like a turtle and serpent combined, with a head also like that of a lizard, armed with sharp teeth? How hideous it looks! I see it is a Plesiosaurus. Notice it has paddles also like a whale; but how enormous they are! they are even much larger than those of the Ichthyosaurus, but its tail, you see, is far shorter.

How those dreadful monsters are glaring at each other! Depend upon it there will be a fight. Look! they are dashing about, and agitating the sea into a white foam, swimming round and round in concentric circles. The Plesiosaurus seems to have a better chance, because it can move its smaller body with more agility with those great paddles and rudder-tail; and though its head is small, its immensely long neck will enable it to dash at the other's body and inflict some severe wounds.

But then those monstrous jaws of the Ichthyosaurus could bite its head and neck off in an instant if once it could get the opportunity of snapping at them. See! they are now close together, and are tearing each other's flesh with their fearful fangs. The blood, however, is not so red as that of our whales—it looks slimy; evidently they are cold-blooded animals.

But listen! it thunders, and the lightning is flashing; there is also something happening in the sea, for the fishes are floating upon the surface dead! A submarine volcano must be ejecting poisonous matter underneath those waters. The monsters have left off fighting, and, both appalled, are making their way straight to the shore. Surely there is an earthquake, for the rock upon which we are standing is trembling, and the cliffs are tumbling down. There, see! see! the Plesiosaurus is buried up at once under that terrific avalanche, and a fissure has opened in the ground which has completely swallowed up that enormous Ichthyosaurus, and closed over it again, shutting it up in the bowels of the Earth, with its late enormous meal still whole in its stomach, to tell its story æons of years afterwards. These dreadful convulsions are terrible! It is more than we can endure, even in imagination; so, gentle reader, we will open our eyes and return to the present era.

A young country girl is picking up fossils to obtain her

livelihood, and, hammer in hand, is chipping away at the rocks, when suddenly she comes upon several bones projecting out from the cliff. She gets some labourers to dig out the block of Lias, and one of the monsters we saw sporting in those ancient seas, and suddenly buried up, now comes to light, after being immured millions of years. It is thirty feet in length, and the first that has been found. This discovery inspires geologists with additional zeal to search the Lias strata for these animals, and Dr. Buckland finds our identical gourmand with the young Ichthyosaurus still within its ribs. Numerous other specimens have since been

Fig. 66.—Showing Eye and Jaws of *Ichthyosaurus platydon.*

discovered, so that our museums now abound with their remains. Often have I examined them with the greatest interest, and I think I shall never forget my sensations when I first saw the eye of a large specimen. The orbit was bigger round than the crown of my hat; when alive its glare must indeed have been appalling.

This eye was also a most marvellous and perfect structure, having in front of the sclerotic coat or capsule a series of thin bony and movable plates surrounding the pupil, which could so press upon it as to enable it to perform the office of a telescope or a microscope, to see things far off or close at hand, and to pursue its prey in the broad daylight and open air or in the darkness and depths of the sea. This dreadful eye is well

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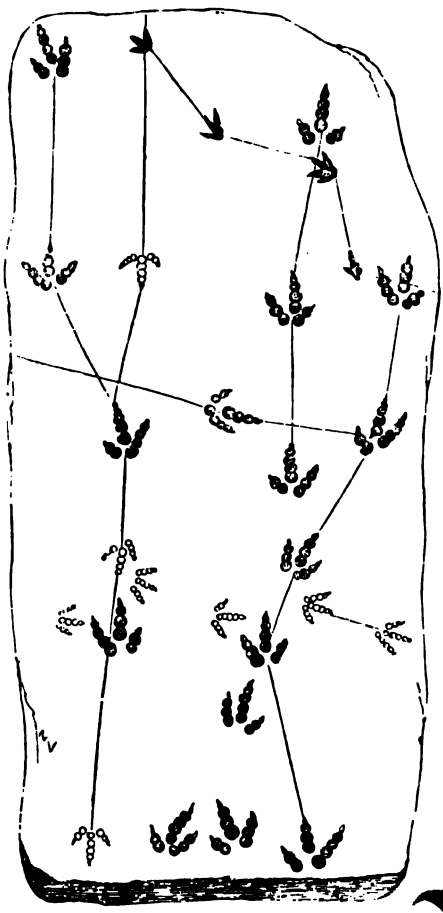

Fig. 64.—Portion of a Slab of New Red Sandstone fr[illegible]er's Falls, Massachusetts, with imprints of footsteps o[illegible]

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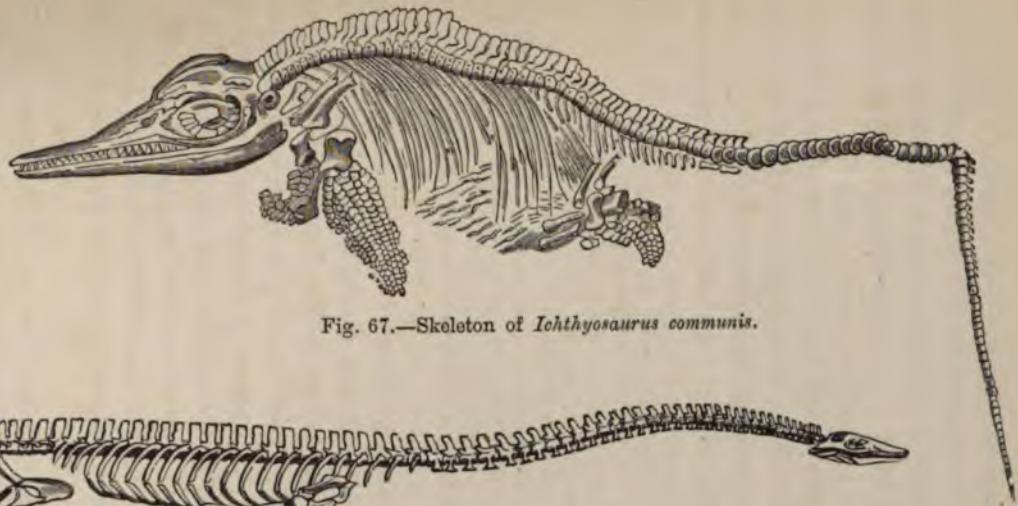

Fig. 67.—Skeleton of *Ichthyosaurus communis*.

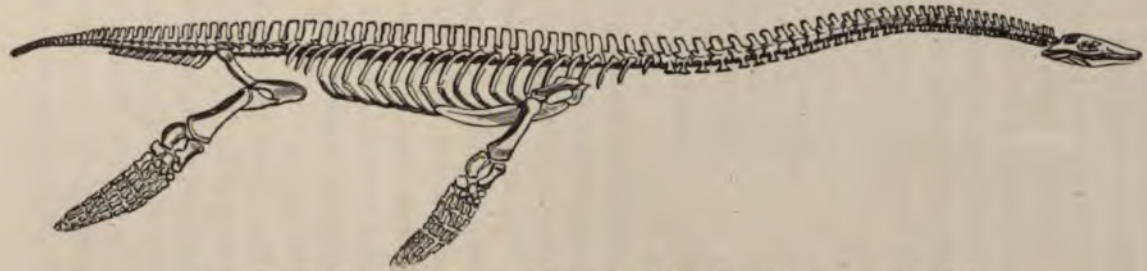

Fig. 68.—Skeleton of *Plesiosaurus dolichodeirus* (restored). (*Conybeare, principally.*)

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* *For note* upon Jonah and the Whale see Appendix.

structure is formed from a simple one by the addition of new material, or, in the learned words of science, by the "integration of matter," and the transition from the "homogeneous" to the "heterogeneous." But the intellect of the Architect rears upon these foundations very different structures. Who so absurd as to say that the castle was "evolved" from the "cottage," because their foundations were similar or even some of their rooms alike?

The answer to this question must be the same as that which can be given to the Evolutionist who claims a community of origin in the organic world because there is a resemblance between their early conditions, which resemblance is only apparent, not real. Most thoroughly do I believe that it can be proved to demonstration that the growth and perfection of organic nature are presided over by a Divine Architect, by whose will and power alone the various structures are built up.

The Oolitic Strata.

As there are several interesting things that can be said about these strata, I will devote a few pages to them. The name is derived from the two Greek words ὠόν, *an egg*, and λίθος, *a stone*, because in the countries where these strata were first examined the rocks consisted of an aggregation of rounded concretionary grains resembling in outward appearance the roe or eggs of fishes; and each of these contains a nucleus of sand, around which concentric layers of calcareous matter have accumulated. But this structure does not prevail through the entire formation, nor is exclusively confined to it, though sufficiently prominent to become characteristic.

The Oolitic group is remarkable for the vast amount of calcareous matter which it contains, for its limestones which are so extensively employed in architecture, and for the great number and variety of its organic remains. The strata have *variously a brown*, a light yellow, or grey tinge, and are

perhaps the most important of the whole series for utility, the stratified calcareous mass furnishing an excellent freestone, of which many public edifices are built, especially our fine old churches. It appears conspicuously in the Cotswold Hills in Gloucestershire, in the beautiful hills near Bath, in the north of France, as the well-known Caen stone of Normandy, and the stone used for lithography and found largely in Bavaria.

Fullers' earth is also obtained from these strata. In the upper division occurs the Portland Stone, which consists of a series of beds of calcareous and siliceous freestone of no great thickness or extent. It is chiefly confined to the county of Dorset, and is highly valuable for architectural purposes, having yielded the material of Somerset House, and of many other public edifices of the metropolis.

The Isle of Portland, where this stone is obtained chiefly, is, properly speaking, a bold promontory off Weymouth, about four miles and a half in length and two in breadth, and the quarries are principally worked by convicts.

The Wealden strata, in Kent, Surrey, and Sussex, come between the Oolitic and the true Cretaceous rocks. They were deposited in fresh water, and consist of ferruginous sands, sandstones, and clays, which extend from Hastings to Tunbridge in the north, and Horsham in the west. The central region or nucleus of the Weald is Crowborough Beacon, which attains the height of more than 800 feet; but the surrounding clay constitutes a flatter tract having an average breadth of about five miles.

Thin beds occur in the clay, separated by argillaceous seams, almost wholly composed of Paludinæ, the shells of a species of freshwater snail, held together by crystallized carbonate of lime.

This limestone, when polished, forms the well-known Sussex marble, so extensively employed by the architects

of the Middle Ages for decorative purposes. The columns, pavements, and monuments in our cathedrals and ancient churches are often composed of it or of the Purbeck marble, a limestone of nearly the same age and kind, but an aggregation of another species of the same shells.

A row of columns in Chichester Cathedral, and those of the Temple Church in London; the tomb of Queen Eleanor in Westminster Abbey, and the throne of the Archbishop in Canterbury Cathedral, are constructed of this material—the fragile shells of humble water-snails once familiar with slime and mud, which have been petrified and agglutinated into an enduring limestone by the mysterious chemistry of Nature, and subsequently converted into polished marble by the art of man! But its use in architecture appears to go back to the era of Roman domination in Britain. In the year 1723 a slab of grey Sussex marble was dug up at Chichester bearing a Latin inscription, recording the dedication of a temple, and it has been thus translated:—

"The College or Company of Artificers, and they who preside over sacred rites, or hold offices there by the authority of King Cogidubnus, the legate of Tiberius Claudius Augustus in Britain, dedicated this Temple to Neptune and Minerva, for the welfare of the imperial family, Pudens, the son of Pudentinium, having given the site."

This valuable relic of the olden time is now in the grounds of the Duke of Richmond at Goodwood, and Professor Plumptre, now Dean of Wells, has written a most interesting article upon it in the *Bible Educator;* but I must pass on to speak of

The Cretaceous Period.

This name was given to these strata because the rocks deposited by the sea towards their close are composed principally of chalk or carbonate of lime.

Carbonate of lime, however, does not now appear for the

first time as a part of the Earth's crust. We have already seen limestones occurring among the rocks from the earliest Silurian period. Carboniferous limestone and the Jurassic formations are largely composed of carbonate of lime in many of their beds, which are enormous in number as well as extent.

I would just notice here the probable sources of this great amount of carbonate of lime in the sea. Large quantities would be brought down by the rivers running through and over limestone rocks, and it may be that there are also thermal springs existing in the ocean like those on land, such as the Geysers in Iceland, the springs of Plombières, and many others, which are strongly impregnated with carbonate of lime. In ancient times carbonic acid doubtless would find its way into the sea through fissures and dislocations caused by the cooling of the crust, and by uniting with the calcareous rocks would form carbonate of lime.

These strata, however, were not formed by the simple deposition of this carbonate of lime at the bottom of the sea, but principally by Foraminifera and Polypi of every variety of form, which swarmed in the ocean, forming an innumerable population, chiefly microscopic. As they died, the perishable animal matter disappeared in the bosom of the waters by decomposition, but there still remained behind the indestructible inorganic matter; that is to say, the carbonate of lime forming the testaceous covering. These calcareous deposits accumulating in thick beds at the bottom of the sea became compacted into a solid mass and formed a series of continuous beds superimposed on each other, and increasing imperceptibly, in the course of ages ultimately formed these Cretaceous rocks.

But little of this was known before Ehrenberg discovered it some forty or fifty years ago, and to him we are indebted for much valuable information which his microscopical researches brought to light.

Some of the Foraminifera can be seen with the naked eye,

but the greater number of them are invisible. Figuier states that many of them are so small that 150 placed end to end would only occupy a space the one-twelfth of an inch; therefore an individual would be $\frac{1}{1800}$th of an inch in diameter, and nearly three millions would be required to cover a square inch; while a cubic inch would contain 5,832,000,000, or four times the whole population of the Earth. Fancy, then, the number of these organisms there must be in our mountains!

In order that you may form some idea of the minuteness of these little shells, take a piece of white paper and mark off an inch in length, then try with the point of a pin to make 100 tiny pricks in a straight line, and you will find it almost impossible to do it within the inch. By looking at these excessively small dots, and imagining them divided into some twenty parts, you will conceive the size of these Foraminifera, and then you must carry the thought still further, and conceive a living organism in that infinitesimal shell, perfect and beautiful in all its parts.

Of course there are other Foraminifera much larger than this, which can be seen by the naked eye, and some specimens may be obtained by shaking out the sand from a piece of new sponge, or by carefully pulverising a soft piece of chalk under water, and collecting the fine grit. Well do I remember when I was a boy, some twelve years of age, being taken by my father to hear Mr. John Brown, of Stanway Hall, near Colchester, lecture upon geology; and I can recollect how enchanted I was with the number, variety, and beauty of the tiny specimens he had washed from the chalk and mounted —some upon black paper, and others as microscopical slides. I can imagine the good man now describing the chalk strata, and telling me how to obtain these wonderful organisms. Soon afterwards I bought my first microscope, which I still *retain amongst* the relics of my boyhood.

Fig. 69 will give you some idea of what these elegant organisms are like. They were prepared by Ehrenberg from the chalk of Gravesend. Other limestones besides the chalk are composed of Foraminifera.

Nummulites, a larger form of Foraminifera, occur abundantly in parts of the Eocene strata, which come above the Cretaceous rocks. Dr. Hogg, in his excellent work, "The

Fig. 69.—Chalk of Gravesend, after Ehrenberg, highly magnified.

Microscope," mentions that the Great Pyramid of Egypt, covering eleven acres of ground, consists of them and of other fossil animalcules. The Nummulites vary in size from an extremely minute object to the dimensions of a crown-piece. The whole of this monster piece of masonry was therefore once alive, and it would be a curious, though possible thing, to put down in figures the enormous number of minute creatures of which it is composed.

The Doctor also says that a chain of mountains in the United States 300 feet high seems wholly formed of one kind of these minute fossil shells. The crystalline marble of the Pyrenees, and the limestone ranges at the head of the Adriatic Gulf, are composed of small Nummulites. Vast deposits of Foraminifera have been traced in Egypt and the Holy Land, on the shores of the Red Sea, in Arabia and Hindostan, and, in fact, may be said to spread over thousands of square miles from the Pyrenees to the Himalayas.

To appreciate the quantity of chalk which was formed during this period I think you could not pay a visit to any place better than Dover. When there, first climb to the top of Shakespeare's Cliff, which is composed entirely of solid chalk; and as you are standing there pray recall the lines of our immortal bard, in which Edgar describes to his blind father, the Duke of Gloucester, the view from the summit:—

"Come on, sir; here's the place; stand still.—How fearful
And dizzy 'tis to cast one's eyes so low!
The crows and choughs that wing the midway air
Show scarce so gross as beetles! half way down
Hangs one that gathers samphire; dreadful trade!
Methinks he seems no bigger than his head.
The fishermen, that walk upon the beach,
Appear like mice; and yon tall anchoring bark
Diminished to her cock; her cock a buoy
Almost too small for sight: the murmuring surge
That on the unnumber'd idle pebbles chafes,
Cannot be heard so high:—I'll look no more;
Lest my brain turn, and the deficient sight
Topple down headlong."

(*King Lear*, iv. 6.)

Having entered into the spirit of Edgar's words, and noticed how true they all are, then make your way to the bottom, and look up its perpendicular face. Its top *will appear almost* to reach to the skies. Now remember

what I said about the number of microscopical Foraminifera in a cubic inch, then try to estimate the number of cubic inches in this hill of chalk, and you will have some slight notion of the number of little creatures that must have died to form the mass before you. Let me help you to do so by calling your attention to the railway tunnels through its base.

These two tunnels are each 4,281 feet long, 12 feet high, and 30 feet broad; consequently, the amount of chalk removed to form them was 3,000,000 cubic feet, and this would give of microscopical Foraminifera, &c.,

30,000,000,000,000,000,000,

a number almost too vast for human conception, though perhaps the following statement may help us a little :—

Supposing we take off 50 per cent. (one-half) for larger shells, flints, &c.—a proportion, I think, far too great—then, if all the 4,000,000 people living in London were engaged in counting the tiny shells, at the rate of one a second, night and day, without any intermission, they would be more than 100,000 years getting through the enormous task.

Look at these tunnels again, and see how insignificant a portion they are of this mighty chalk cliff; and then think of all the other cretaceous deposits in the world, and you will, I am sure, be convinced that it must have taken many thousands of years to form these cretaceous deposits.

Look again at Gen. i. 20, 21, and 22, and you will find that this abundance of marine life is mentioned three times over. What could be more interesting and striking than such a fact, inasmuch as not only before the sea-monsters, but afterwards, the sea teemed with a great abundance of life? Also, it is worthy of notice that the fowls are mentioned three times, and I have shown that they also existed both before and after the "sea-monsters." Thus we find the accuracy of Moses beyond measure marvellous.

I will now explain how this chalk has been turned into

Marble.

You will remember that I mentioned the eruptive rocks—such as granite, trachyte, basalt, lava, and porphyry—having been forced through fissures in the Earth's crust; if, then, you will look at the diagram, page 386, you will at once understand that such intensely heated masses passing through strata would considerably change their condition. The coal would be changed into anthracite or graphite, the sandstone into quartzite, the shales into crystalline schist, and the limestone into marble, for some distance around the eruptive rocks. The effect on the chalk would therefore be to alter it, and as it cooled very gradually it would assume a crystalline structure.

In many cases so entirely have all vestiges of fossils been destroyed, that some marbles were formerly thought to be of primary origin, and therefore before organic life dawned upon the world, as in the case of Carrara marble; but this has now been found by the Government Surveyors of Italy to be an altered limestone of the Triassic period, long after a variety of both animals and plants had appeared. But as these beds are very extensive, other causes besides that of eruptive rocks must have brought about their present condition.

I think, however, I had better refer my readers to an excellent explanation of these causes in Lyell's "Elements of Geology," chap. xxxv.

The *Illustrated London News* some years ago gave an excellent description of the Carrara quarries, of which the following are a few particulars:—

The magnificent chain of mountains in which the quarries are situated juts out at an angle from the Apennines, and *forms a portion* of the Duchy of Massa Carrara. The aspect

of these stupendous and "marble-hearted" heights, as seen from the sea-shore, whence they are distant about four miles, is highly picturesque. Almost destitute of vegetation, they gleam in the sunlight like masses of brass; while at intervals rugged and inaccessible peaks jut out sharply against the sky and appear to pierce into the clouds. In numerous directions, about midway up the heights, the eye is attracted by what seems to be a vast torrent pouring down its resistless volume of seething water into the valley, but which is in fact the shoot of the refuse flung out of a quarry immediately above. On the flank of a few of the mountains, and near their bases, some stunted vegetation, consisting mostly of dwarfed oaks and chestnut-trees, may occasionally be seen; while nearer to the summit, in the fissures and gullies, a sickly and scanty herbage affords sustenance to troops of goats.

The quarries are generally situated about half-way up the mountain, and although they are said to have furnished the ancients with the material for building the Pantheon at Rome, and more recently have supplied nearly every civilised country throughout the globe with their precious contents, to the extent of an export amounting annually to an average of 150,000 tons, the workmen are still employed upon the surface; and so little effect has the labour of centuries produced upon the general appearance of the quarries, that they may be safely affirmed to be inexhaustible.

This white marble was the favourite material of ancient Rome, and is still that of modern Europe, on account of its purity of colour, its delicate transparency, and its granular texture, which renders it much more easy to work than compact limestone.

Carrara marble has only one rival in the world, and that is the Parian, obtained from Paros, near Athens, which is extremely pure, consisting only of carbonate of lime, and being softer and more transparent than Carrara marble.

These wonderful quarries extend over many square leagues, and give employment to some 2,500 men, who are able to undergo great fatigue in the execution of their daily labour, and are as frugal as they are industrious.

Surely we must look upon it as part of the great design of the Mighty Architect of the world, who from the first intended that man should have much, very much, that was beautiful, and therefore so ordained and regulated the various operations of His laws that such should be one of the ultimate

Fig. 70.—Shell in a Boy's Marble.

results, endowing man at the same time with intellect and talent to shape this beautiful material into forms which should delight and charm the beholder.

I have mentioned that some marbles from their crystalline structure were formerly supposed to be of primary origin; the above drawing (Fig. 70) is an interesting illustration to the contrary. When a boy, I was playing marbles with a schoolfellow, whose ally-taw suddenly broke, and he brought it to me to look at as having a rather curious fracture. I think I offered him two for it, which he most willingly accepted, and I joyfully pocketed my prize, for the small round piece of marble had broken just where a perfect shell was embedded in it, and was preserved entire to tell its story ages upon ages after the death of its occupant, and to *help to establish* the marine origin of the crystalline limestone.

It also was not a little singular that in the manufacture of the taw the shell remained uninjured; for the least turn of the workman's wheel on either side would have cut off a portion of the shell. Professor Owen and other eminent geologists who have seen it pronounce it to be a very rare and beautiful specimen, and I look upon it as one of my special treasures, which I should not like to part with for many times its weight in gold.

For this I am indebted to Professor Brown, for if I had not heard his lectures I should not have known its value, and perhaps it would have been thrown away by my schoolfellow and myself as a useless thing. This leads me just to notice the great benefit scientific lectures are to boys, even when very young; for if the subjects are but popularly treated, they excite in them feelings of interest and curiosity which prompt them to inquire and to read for themselves further explanations of the same subjects; and not only so, but they are led early to think of the wisdom and power of the great Creator whom, at their mothers' knees, they have been taught to adore. With the most grateful feelings do I look back to the time of my early boyhood, when, as I have mentioned, my father took me to lectures of this kind; and intensely delighted was I to see the wonderful and beautiful experiments in chemistry by Mr. George Firmin, the interesting orrery and astronomical apparatus of Mr. Lloyd, the lovely flowers used by Mr. Bunting to illustrate his lectures on botany, and Professor Brown's charming collection of fossils. Though some of these early scientific friends have passed away, I would wish to render this tribute to their memory, and to say that the foundation they laid in my mind of scientific thought and inquiry has helped to render my whole life, since, bright and happy, even when trials of various kinds have fallen to my lot.

Perhaps I may be pardoned for mentioning one other

friend of my boyhood who encouraged me in scientific pursuits, and whose name I should like to appear in these pages. Many happy days did I spend at the country house of Mr. James Tabor, when I was about fourteen years of age, measuring the heights of his trees and buildings with a little wooden instrument I had made; and I have not forgotten the pocket-money which he sometimes slipped into my hand to encourage me in my scientific pursuits. Most delighted was I on re-visiting Colchester a few years ago to find my old and much-esteemed friend still living, and even continuing to sit upon the magisterial bench.*

There is another excellent result also from this early acquaintance with the elements of science, namely, that some boys take up one particular branch of science as a hobby, which relieves and interests them in their leisure hours in after life. Sir David Barclay, who is one of our greatest conchologists, told me that his mother did her best to give all her sons hobbies, for she had great faith in their beneficial tendency. He chose shells, and for forty or fifty years he has so devoted himself to their collection that I believe he has the largest private collection in the world. I have heard him say that when out with his regiment in tropical countries he was preserved from the *ennui* and follies that other young officers often fall into, by this excellent occupation for body and mind. Only let the hobby be of a useful and elevating character, it matters not whether it be music, painting, botany, geology, astronomy, or any other art or science, it will always prove a blessing and a constant joy. Let these subjects also be accompanied with religious thought, and the gratification will be enhanced a hundred-fold.

I shall never forget the first time that I accompanied my father through Kew Gardens, how he expressed his pleasure

* Whilst the first edition was in the press, I received the intelligence *that my friend* had passed away from earth to heaven.

and interest in every flower and tree; but when he came to the large tropical conservatory, his eyes lightened up with more than usual brilliancy, and he exclaimed, with Cowper, "My Father made them all." It was this feeling of relationship with God which caused the dear old man so intensely to enjoy His beautiful and wondrous works. The scientific man, however skilful he may be in his department of physics, who cannot enter into these sentiments can form no conception how much he loses of a higher and heart-felt interest; for the study of Nature to the devout mind produces an amount of enjoyment the intensity of which no words can express. Such a man sees in the various laws which are in operation throughout the Universe unbounded benevolence as well as infinite sublimity, grandeur, and perfection.

"His are the mountains, and the valleys his,
And the resplendent rivers. His to enjoy
With a propriety that none can feel
But who, with filial confidence inspired,
Can lift to heaven an unpresumptuous eye,
And smiling say—'My Father made them all!'
Are they not his by a peculiar right,
And by an emphasis of interest his,
Whose eye they fill with tears of holy joy,
Whose heart with praise, and whose exalted mind
With worthy thoughts of that unwearied love,
That planned, and built, and still upholds, a world
So clothed with beauty for rebellious man?"

(*The Task*, book v.)

Land-Saurians.

There were a few land-saurians in the Carboniferous period, amongst which were the Labyrinthodonts. In the Permian and Triassic period there were also some large reptiles, and others in the Oolite; but it is during the later time of the Ichthyosaurus that we find monster land-saurians appearing, one or two of which in the Wealden period I must more particularly mention. I dare say many of my readers have seen in the grounds of the Crystal Palace excellent models of some of the most remarkable ancient animals, which were designed by Professor Owen and modelled by Mr. Waterhouse Hawkins.

Amongst them is the Megalosaurus, intensely ugly and of enormous size, being some fifty or sixty feet in length from the tip of its nose to the end of its tail, and found in the ferruginous sands of Cuckfield in Sussex, in the upper beds of the Hastings sands.* The head is so large that I could scarcely find an adjective forcible enough to describe it. It seems to have been amphibious, and to have fed upon crocodiles and tortoises. Only fancy what tough morsels for a dinner, considering that a rifle-ball will glance off the hard scales of the former, and a waggon might pass over the shell of the latter without injuring it. One might as well think of eating flag-stones.

To masticate such hard stuff, the creature was endowed with teeth which partook of the nature of a knife, a sabre, and a saw. The backward curvature taken by the teeth at their full growth would render the escape of its prey, when once seized, an impossibility. You will see this in Fig. 71.

Cuvier had not seen much of the remains of the Megalo-

* Owen says that remains of the Megalosaurus have been found as far down as the Lower Oolites at Selsby Hill.

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XII.—Ideal Fight between an Iguanodon and a Megalosaurus.

saurus, and yet he said it must have been from forty to fifty feet in length. It has been asserted of him, in reference to his description of another reptile, that before ever he had seen a single vertebra or a bone of its extremities he was able to announce the character of the entire skeleton from an examination of the jaws and teeth alone, or from a single tooth—a result, as Dr. Buckland observes, of those magnificent laws of

Fig. 71.—Lower Jaw of the Megalosaurus.

co-existence which form the basis of the science of Comparative Anatomy.

Remarkable as this power of reasoning may seem, even more wonderful things I have heard tell were done by Quekett, who could take up a small piece of bone the size of a nut, or even less, and tell at once, by examining the cells under a microscope, what animal it belonged to, whether an elephant, a lion, or a mouse. Surely this is another evidence of the creation of separate species; for the microscopic cells in the bones would scarcely be likely to differ in so marked a manner if all animals had a common origin.

The Iguanodon was still more gigantic than the Megalosaurus; one of the most colossal, indeed, of all the Saurians of the ancient world which research has yet exposed to the light of day. Professor Owen and Dr. Mantell were not agreed as to the form of the tail; the former gentleman assigning it a short tail, which would affect Dr. Mantell's estimate of its

probable length of 50 or 60 feet; the largest thigh-bone yet found measures 4 feet 8 inches in length. The form and disposition of the feet, added to the existence of a bony horn on the upper part of the muzzle or snout, almost identifies it as a species like the existing Iguana, the only reptile which is known to be provided with such a horn upon the nose. There is, therefore, no doubt as to the resemblance between these two animals; but while the largest of living Iguanas scarcely exceeds a yard in length, its fossil congener was probably fifteen or sixteen times that length. It may aid you to form an idea of the enormous size of the Iguanodon when I tell you that a party of gentlemen dined inside the model at the Crystal Palace when it was first finished, two of whom were Professor Owen and Professor Forbes.

Why these monster saurians were created, it would be impossible for us to say, nevertheless we must feel assured that they had some important part to play, for when He had created them "God saw that it was good."

CHAPTER IX.

"And God made the Beast of the Earth."

This sixth and last vision was evidently prolonged. The account of it occupies the second chapter of Genesis, and I shall by-and-by call special attention to the various circumstances related in that chapter.

Before I describe these beasts, let me say that when I was studying carefully the events recorded by Moses, I was afraid that in this instance the perfect order of arrangement was at fault, for in the 24th verse the Cattle are placed before the Beasts; but I soon saw that such was not the case, for this 24th verse is only a sort of preface. Directly afterwards Moses says emphatically, "*And God made the Beast of the Earth after his kind, and Cattle after their kind;*" here, then, the perfect scientific order is quite maintained.

Tertiary Strata.

These strata, we find, also confirm our Biblical story in every particular; for, as before sea-monsters stood out prominently in the scenes connected with the Secondary strata, so now too monster beasts roam amongst the forests of the Eocene, Miocene, and Pliocene periods.

The Pachyderms (from the Greek *πάχύς, thick,* and *δέρμα, skin*) seem to have been amongst the earliest mammals which appeared in the Eocene period; and they held the first rank, from their importance in number of species as well as in size. Cuvier insisted that their predominance over other fossil mammals exceeded considerably the number now living. Among them also were a great many intermediate forms, which we seek for in vain in existing genera. Their

great tomb is the plaster quarries of Paris, Montmartre, and Pantin; each block taken from those quarries encloses some fragment of a bone of these mammals, of which I shall only select a few.

The Palæotherium, or "ancient wild beast," seems to have been intermediate, according to organisation, between the

Fig. 72.—*Palæotherium magnum* (restored).

rhinoceros, the horse, and the tapir, and there seem to have existed many species of them of very different sizes. After the labours of Cuvier, nothing is easier than to represent the Palæotherium as it lived—the nose terminating in a muscular fleshy trunk, or rather snout, the feet supported by three toes enclosed in a hoof, the size of some species that of a large horse. These animals fed on vegetables, and peaceful flocks *of them must* have inhabited the valleys of the plateau which

surrounds the ancient basin of Paris, the lacustrine formation of Orleans and Argenton, the Tertiary formation of Issil and Pay-en-Velay, in the department of the Gironde, the Tertiary formation near Rome, and the beds of limestone at the quarries of Binsted in the Isle of Wight.

Fig. 72 represents a restoration of the great Palæotherium, after the design given by Cuvier in his work on fossil bones.

Fig. 73.—Dinotherium (restored).

The discovery and re-arrangement of these, and other forms now swept from the face of the globe, are the noblest triumphs of the great French zoologist, who gathered them, from time to time, from heaps of confused fragments huddled together pell-mell, comprising the bones of a great many species of animals of a former age of the world, and all unknown within the historic period.

The most remarkable of these animals in the Miocene is perhaps the largest terrestrial mammal which has ever lived, and called the Dinotherium (from δεινός, *terrible*, and θήριον, *wild beast*)—rather an unsuitable name, by the way, for its habits seem to have been peaceful enough, though certainly its size must have been frightful, perhaps not less than sixteen feet high and twenty feet long. The head measured three feet across—a breadth, Hugh Miller facetiously remarks, to satisfy the most exacting phrenologist.

It had a trunk like an elephant's, and two tusks from the extremity of the lower jaw, curved inwards somewhat like those of the walrus. In all probability it used them as a pickaxe to dig up aquatic plants and liliaceous roots, on which the creature seems to have lived; and also they might have been useful to drag itself out of the water when it wished to walk about on land. I heard Dr. Woodward humorously suggest that they might be perhaps used to anchor it to the bank when the creature desired to sleep on the surface of great fresh-water lakes and large rivers.

You will notice in our engraving (Fig. 73) that it resembles an elephant in many respects, but differs essentially in the form of its tusks; and it was altogether very much larger in bulk. Its mouth must have been enormous, for the lower jaw was four feet long, and its stomach was doubtless in proportion; so that, if it lived now, a load of hay would only serve it for a few meals.

In this Miocene period there appeared another animal of great size, resembling our elephant, and called the Mastodon (μαστός, *a teat*, and ὀδούς, *a tooth*), from the form of its molar teeth. Fig. 74 is a representation of a tooth found in Pennsylvania, which weighed seventeen pounds, and was nearly as big as a man's head; pretty strong muscles it must have had to work jaws with such teeth as

these. It had long tusks in the upper jaw, and in some specimens there were smaller ones in the lower jaw.

Dr. Hunter thought it was a carnivorous animal; but Cuvier was quite opposed to such an idea, and pronounced it herbivorous. Lyell gives a very striking and interesting confirmation of this. He says that at New Jersey, six feet below the surface, a farmer was digging out the rich mud from a small pond, and found a perfect skeleton of a very large Mastodon; and within its twenty ribs were seven bushels

Fig. 74.—Molar Tooth of Mastodon.

of vegetable matter, which, on being submitted to microscopic examination by Mr. Henfrey, was found to consist of minute pieces of small twigs of a coniferous tree of the Cypress family, upon which most probably the creature fed.

To form some idea of this enormous undigested meal, you must master the fact that it is equal to 224 half-quartern loaves, which would be enough to give 448 men a breakfast of a pound of bread each, requiring the addition, of course, of some fresh butter and hot coffee.

Probably the largest specimen ever found was exhumed in 1845, in the town of Newbury, New York. The length of

the skeleton was twenty-five feet, its height twelve feet, and the tusks ten feet long. When alive, with all the flesh, skin, and hair upon it, of course it would be still larger; and therefore if you will go into a room thirty-five feet long and fourteen feet high, and imagine the Mastodon to be standing in it, it would pretty nearly fill the whole space.

Fig. 75.—*Elephas primigenius* (Pleistocene).

There was another huge animal whose remains are often found in the Pleistocene; it greatly resembles the Mastodon, but it was still more like the elephant in the form and the structure of its teeth, and therefore naturalists have named it *Elephas primigenius* (Fig. 75). It is also called a Mammoth, because the Tartars supposed it to have dwelt under the earth. It was covered with three kinds of hair: first, strong bristles, a *foot in length;* secondly, with a kind more flexible; and thirdly,

with a reddish wool growing amongst the long hair. This made Cuvier think that it belonged to a race adapted to live in cold climates. Certainly it is remarkable that so many remains should be found in Siberia, where it might have been cold in the Quaternary period.

They are found, however, nearly all over England, in parts of Ireland and Scotland, also in Iceland and Sweden, as well as from the plains of Quito to the United States. Those found in Italy were once supposed to have been the elephants which were in the army of Hannibal, and even those found in England were thought to have been brought here by the Romans. Neither of these assumptions, however, is correct; and the anatomical examination of the fossils has proved the animals to be of distinct species.

Doubtless you will ask how we came to know about its hair and the other particulars I have given. This you will quite understand from the following narrative, the particulars of which I have collected from different sources:—

In 1799, a Tungusian fisherman, named Schumachoff, who generally went to hunt and fish at the peninsula of Tamut, after the fishing season of the Lena was over, had constructed for his wife some cabins on the banks of Lake Oncoul, and had embarked to seek along the coast for Mammoth tusks.

During this expedition he one day observed a strange, shapeless mass projecting from a bank; the nature of it he did not understand, and it was situated at such an elevation as to be beyond his reach. The bank consisted of frozen earth covered with ice, partially thawing in the summer season. Returning to the same spot the succeeding year, 1800, he observed the object rather more disengaged, yet still could not determine what it was; but towards the close of the year 1801 he could distinctly see that it was the frozen carcase of an enormous animal. By-and-by

the ice melted, and the animal fell from the crag on to a sandbank forming part of the coast of the Arctic Ocean. In 1804 Schumachoff came to the Mammoth and carried off the tusks, which he sold to a merchant for 50 roubles. In 1806, the seventh year from the discovery, Mr. Adams, travelling in that distant and desert region on an embassy to China, with Count Golovkin, examined the animal, which still remained on the sandbank where it had fallen, but in a greatly mutilated condition. The wandering fishermen had taken away large quantities to feed their dogs; the wild animals—white bears, wolves, wolverines, and foxes—had also feasted on the carcase; but the skeleton remained quite entire, with the exception of one of the fore-legs. The entire spine, the pelvis, one shoulder-blade, and three legs were still held together by their ligaments and by some remains of the skin; the pupils of the eyes were still distinguishable; the brain remained within the skull, but a good deal shrunk and dried; and one of the ears was in excellent preservation, still retaining a tuft of strong bristly hair.

The animal was a male, had a long neck, and was one of the largest size. The skin was extremely thick, and so heavy that ten men could scarcely carry away that part which was undestroyed.

Mr. Adams believed he had the good fortune to repurchase the tusks from the merchant to whom they had been sold, but there are grave doubts as to their identity. He finally transported the whole skeleton to St. Petersburg, where it is now in the museum of the Academy.

The skull of this monster weighs 414 pounds, which is more than three and a-half hundredweight. Its tusks are nine feet six inches in length along the curve; the head and feet are still covered with the hair and skin, so that it is facetiously called a Mammoth in boots (Fig. 76).

There was a quantity of hair and wool trodden into the

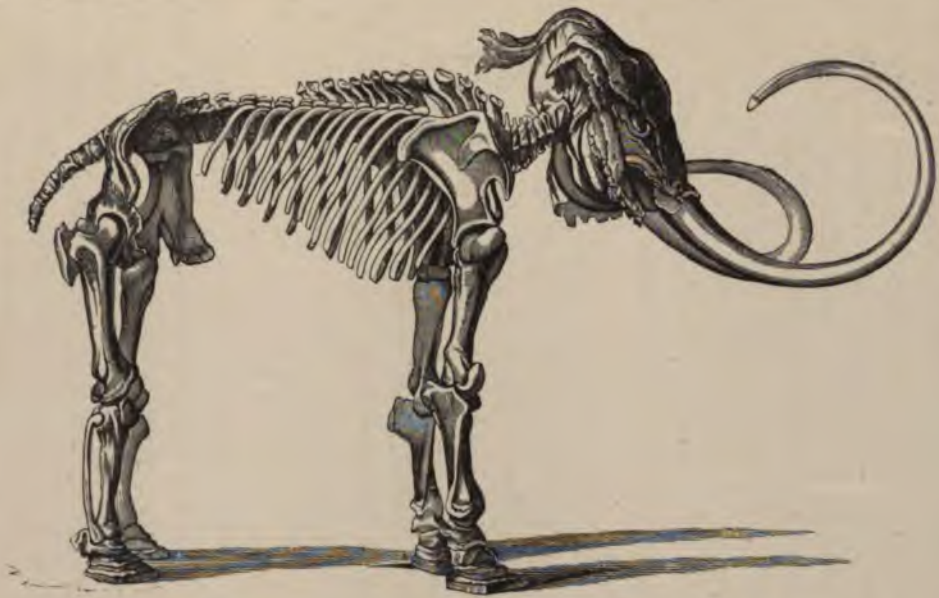


Fig. 76.—Skeleton of the Oncoul Mammoth in the Museum at St. Petersburg.

ground by the bears and wolves, and on this being collected it weighed 36 pounds. It is impossible for us to thank Mr. Adams sufficiently for his zeal and earnestness, in not only following up the matter until he collected the remains of this ancient creature, but also in getting them all conveyed to St. Petersburg—a distance of 11,000 versts, or 7,330 miles. The Emperor of Russia, who became the owner of this precious relic, paid him 8,000 roubles for his trouble.

Numerous other examples have been since found in Siberia, and some very interesting specimens of the Mammoth have been found in this country. One obtained at Ilford, in Essex, is a very large skull, having immense tusks ten feet eight inches long.

After careful measurement, and comparing the size of these tusks with others whose weight is well known, I have come to the conclusion that they must, when the animal was alive, have weighed at least 500 pounds—that is, 250 pounds each; and as the leverage of such long tusks would be very great, the neck of the animal would have had to sustain some *tons*. The real amount of this strain upon the neck I should not like to state. It would seem like an exaggeration, but any one acquainted with the method of solving such questions will be able to ascertain it from the figures I have given.

This mammal is supposed to have continued until the advent of man; it is pretty certain, however, that it existed in the Quaternary period as late on as the Post-Glacial era.

As another example of the inhabitants of the Earth in the Pleistocene period, I will introduce you to a most extraordinary and huge beast, and I will get you to look first at his skeleton (Fig. 77), and then at his restoration by Figuier (Fig. 78), and, if not too much frightened at its appearance, listen to its description. It rivalled in size the largest rhinoceros, was armed with claws of enormous length and power, its whole frame possessing an extreme degree of solidity; while

its head and neck were like those of the sloth, its legs and feet exhibit the character of the armadillo and the ant-eater. Some specimens of the animal give the measurement of five feet across the haunches, and the thigh-bone was nearly as thick as that of the elephant.

The spinal marrow must have been a *foot* in diameter, and the tail at the part nearest the body was 6 feet in circumference. The girth of the body was 14½ feet, and the length 18 feet. The teeth were admirably adapted for cutting vegetable substances upon which it lived, wrenching off branches of trees, or uprooting their trunks with its monstrous paws, a yard in length, and then munching the tough woody fibre with as much pleasure doubtless as we should eat a maccaroni biscuit.

Dr. Buckland, in his eloquent description of this animal, says:—

"It could neither run nor leap, nor climb, nor burrow under ground, and all its movements must have been necessarily slow; but what need of rapid locomotion to an animal whose occupation of digging roots for food was almost stationary? and what need of speed for flight from foes, to a creature who, by a single pat of his paw, or lash of his tail, could in an instant have demolished the Couguar or the Crocodile? Where was the enemy which would dare encounter this Behemoth of the Pampas? Or in what more powerful creature can we find the cause that has effected the extirpation of his race? His entire frame was an apparatus of colossal mechanism, adapted exactly to the work it had to do; strong and ponderous in proportion as this work was heavy, and calculated to be the vehicle of life and enjoyment to a gigantic race of quadrupeds, which, though they have ceased to be counted among the living inhabitants of our planet, have in their fossil bones left behind them imperishable monuments of the consummate skill with which they were constructed."

I have purposely left out of Dr. Buckland's description the allusion he makes to its armour, for it was at one time thought to have been covered with a dense coat of mail,

like the armadillo, because thick plates had been found near to it. These plates, however, Professor Owen has shown to have belonged to an animal which lived at the same time, and which he called a Glyptodon, from the structure of its teeth. Our huge friend was probably covered with hair.

We are chiefly indebted to the zeal and energy of Sir

Fig. 77.—Skeleton of the Megatherium (foreshortened).

Woodbine Parish for the materials from which our naturalists have been enabled to re-construct the Megatherium. The remains collected by him were found in the river Salado, which runs through the flat plains called Pampas, to the south of Buenos Ayres. A succession of three unusually dry seasons had lowered the waters to such a degree as to expose part of the pelvis to view, as the skeleton stood upright in the mud forming the bed of the river.

Further inquiries led to the discovery of the remains of two other skeletons near the place where the first had been found. In 1839 the interesting discovery was made of a nearly perfect adult Megatherium, on the banks of the Rio de la Mataza. There were all the vertebræ of the body,

Fig. 78.—The Megatherium (restored).

the ribs, the teeth, the head, the legs, and every part excepting the tail and one foot; with these remains was also found a perfect young one, so small that their destruction must have taken place almost immediately after its birth.

Mr. Darwin met with the remains of these animals extensively in various parts of South America, where they seem to have browsed in large herds upon the luxuriant vegetation of that continent during the Post-Pliocene period.

There were many other animals equally remarkable for their size, and some of them were carnivorous. But I feel that I have given you a sufficient number to illustrate my subject, and to show that the first appearance of beasts on the Earth was before the cattle. And here again the facts which the strata teach us perfectly coincide with Moses' statement.

The Advent of Cattle.

"And Cattle after their kind."

The oxen which existed in the Pleistocene period, if not

Fig. 79.—Dinornis and *Bos Pallasii.*

identical with, were at least very near to our living species. There were three species—*Bison priscus, Bison primigenius,*

and *Bison Pallasii*. The first had slender legs, with convex frontal broader than it was high; it differed but slightly from the Aurochs, except in being taller and having larger horns.

The remains of *Bison priscus* are found in England, France, Italy, Germany, Russia, and America. *Bison primigenius* was, according to Cuvier, the ancestor of our domestic cattle. *Bos Pallasii* is found in America and in Siberia, and resembles in many respects the Musk-ox of Canada.

We give the representation of one standing with a Dinornis, one of the largest birds yet found, which, strange to say, was wingless (Fig. 79). Where these mammals are found we generally discover the fossil remains of several species of Deer. Of these the most remarkable is the Irish Elk, *Cervus megaceros*, one of the most magnificent of the ancient animals, whose remains are still frequently found in Ireland in the neighbourhood of Dublin, more rarely in France, Germany, and Italy. It was something between an Elk and a Fallow Deer: it stood ten feet high, and exceeded in bulk and size the largest horse: its horns, however, were most magnificent appendages, and must have given to the animal a very imposing appearance. The length of these horns was between nine and ten feet, and they were so divergent that they were often twelve feet asunder from tip to tip.

Skeletons of these large stags (Fig. 80) are found in deposits which underlie the peat moss of Ireland and other places, and often with the head thrown back—as if they had become suddenly immersed in marshy ground, and had thrown it back in order to breathe to the very last.*

Sheep, it seems, did not appear until just before man, which is not a little remarkable, and confirms the supposition that they were created especially for him, to furnish for his sustenance both food and clothing. Hugh Miller makes a particular note of this in his "Testimony of

* Remains of this animal were found in 1882, whilst digging near Charing Cross for the foundations of Messrs. Drummond's Bank.

the Rocks," and says that up to his time no fossil remains whatever of this animal had been found.

Creeping Things.

"And every thing that creepeth upon the Earth after his kind."

With regard to this word, שֶׁרֶץ (*shērĕts*), it is doubtless a term intended to include reptiles and all smaller land-animals, and, perhaps, every possible form of animal life which had not previously been mentioned or classified.

The word בָּרָא (*bārā*), to create, not being used here, this passage cannot refer to the first appearance of such animals, for in the Carboniferous period reptiles of the lowest order seem to have been numerous, and allied to the Batrachian order, to which belong frogs, newts, and salamanders.

In the Carboniferous, Permian, and Triassic rocks remains of a monster kind of toad are found, which animal excited much interest some time ago, and was called the Labyrinthodon, from the complicated structure of its teeth.

Insects of the dragon-fly family existed as far back as the Old Red Sandstone, and being carnivorous creatures, doubtless there were other insects too upon which they fed, which in turn lived upon the early vegetation of this period. Please note that the dragon-fly has an enormous number of eyes, and therefore it also must have had the perfect nervous system which I have before described when speaking of the trilobite; and yet it was amongst the very earliest forms of terrestrial animal life.

During the vegetation of the Coal Measures the number of species of insects increased; but they were still not numerous, and were principally composed of earth-beetles and their grubs. Along with them we also find spiders, locusts, scorpions, and cockroaches. Of these last, two well-preserved specimens were found in the Coal Measures of Bohemia.

The beetles appear to have been of the wood and seed-devouring kinds, and would probably have found their food among the Conifers. The Phasmidæ and grasshoppers would have lived upon tender shoots of the less rigid plants their contemporaries; and the cockroaches upon anything, for they are foul feeders—books, manuscripts, leather, ink, oil, meat, and even the bodies of the dead, are devoured indiscriminately by these scavengers in the warmer parts of the globe. Hugh Miller relates that he had amongst his books an age-embrowned copy of Ramsay's "Tea-Table Miscellany" that had been carried into foreign parts after it had seen hard service at home, and had become smoke-dried and black; and yet, even though so untempting, it was not safe from the cockroaches; for finding it left open one day, in thirty minutes they ate out half its table of contents, consisting of several leaves. They, therefore, doubtless would not have lacked food amid the abundant flora and meagre fauna of the Coal Measures.

In these rocks not a single insect has been found of the now numerous kinds that seek their food amongst flowers; which still further confirms what I said about the vegetation of the Coal Measures, and of its not consisting of grass, herbs, and fruit-trees.

The remark I made in reference to the birds as a probable reason for the scarcity of their remains in some strata, would apply still more forcibly to flying insects, which not only could easily escape from the dangers that overwhelmed the beasts and cattle, but their substance also was of a more perishable kind, having no hard bony structure to resist the combined action of air and water.

Notwithstanding the small chance of their being preserved, we do find specimens of the most fragile species; for Lyell has even given a drawing of a butterfly found in the *marlstone* (the Lower Miocene) of Radaboj, in which the

very pattern of the wings remains, and he tells us that these strata are rich in insect fauna. There are, he says, ten species of Termites, or white ants, some of gigantic size, and large dragon-flies with speckled wings, like those of the Southern States in North America. Grasshoppers also abound in considerable number. I wish, however, to point out a very remarkable manner in which some insects have been preserved.

The old Conifers, like their present allies, exuded from their trunks a resinous sap which, on drying, formed a hardish substance, and not being soluble in water, has resisted for ages the action of the weather.

This dried sap of the ancient trees, our *amber*, is found in all parts of the world, but by far the most abundant supply is obtained in East Prussia, along the coast of the Baltic, between Memel and Dantzic, and especially on the shore near Königsberg.

At various times the origin of amber has been a matter of dispute among naturalists, some describing it as an animal substance resembling bees'-wax, and secreted by an ant inhabiting pine forests; others maintaining it to be a fossil mineral of antediluvian origin.

It was Göppert who proved that it was an indurated resin derived from the various trees of the family of the Coniferæ, but he was not first in this, for the great Roman naturalist Pliny speaks of amber as a resinous juice oozing from old pines and firs, and discharged by them into the sea.

The Greek name for it was *ἤλεκτρον*, and as it possesses electric properties which are strongly developed by friction, it gave the name to electricity. Tomlinson says that those employed in working in amber are subject to nervous tremors, in consequence of handling continually such a highly-excitable electric substance.

Now in this amber are frequently found insects (Fig. 81),

some of which are entire, whilst others are broken and their legs separated; the cause of this can be readily understood, for whilst the sap was fluid and sticky, an insect getting upon it would have but a poor chance of escaping again; and whilst held thus firmly, more sap exuding would cover it up entirely and preserve it for ever from decay. The broken legs or wings in some specimens show pretty clearly that the little creatures often struggled hard to escape, and could only do so by leaving some of their members behind. Amongst these

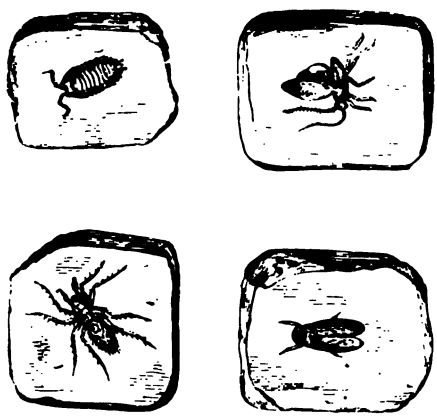


Fig. 81.—Insects in Amber.

insects, bees, wasps, gnats, spiders, and beetles have been found; but as they seem to resemble the species of tropical climates, we may learn, I think, that the countries which are now cold were at that time warm, or even hot.

Another fact is also taught us, namely, the period when flowering trees commenced; for the mission of the bee and of other like insects which visit flowers has doubtless always been to carry the pollen from one blossom to another, and thereby to cause fructification. The bee being covered *with hair, this* pollen readily adheres to its legs and body,

and is carried to the next blossom, which it inoculates when diving down for the honey.

Do, pray, stop for one moment, and admire this wise and admirable arrangement. The structure of the bee is peculiarly adapted for the adherence of this pollen; it has implanted in it the love of honey, which is put at the *bottom* of the flower to attract the insect, and in the endeavour to reach which it brushes past the stigma and leaves some of the fructifying pollen upon it. Of course we know that the pollen gets upon the stigmas by other means as well as through the agency of the bee; but that the latter is a special and remarkable instrument for carrying out this operation of Nature is an undoubted fact.

This adaptation can be shown to exist still further. The earliest flowers, those of the Upper Cretaceous period, were mostly polypetalous, and could be fertilized by many insects. The flowers with a single corolla (such as the bluebell) came later, and then could only be fertilized by insects with a long proboscis, such as the butterflies and moths, which seem not to have appeared till the Tertiary period (see Dr. J. E. Taylor, in *Popular Science Review,* Jan., 1878).

But I have something more to say about the bee. It carries home to its hive a quantity both of the honey and the pollen, which it manufactures into different substances for separate uses; the honey it deposits in cells constructed with mathematical exactitude, each being a perfect hexagon—one of the only three figures of which numbers can be placed together without leaving any interstices. And, further, the bottoms of these cells are even still more wonderful, as I will explain.

Every comb contains two sets of cells, one opening on each of its faces. The cells of one side, however, are not exactly opposite to those of the other; for the middle of each cell abuts against the point where the walls of the three cells

meet on the opposite side, and thus the partition that separates the cells is greatly strengthened. This partition is not flat, but consists of three planes which meet each other at a particular angle, so as to make the centre of the cell its deepest part. Of the three planes which constitute the floor of each cell, one forms part of the bottom of each of the three cells, against which it abuts on the opposite side.

Now it can be proved by the aid of a difficult and elaborate mathematical calculation that, in order to combine the greatest strength with the least expenditure of material, the edges of these planes should have a certain fixed inclination; and the angles formed by the bees were ascertained by the measurement of Maraldi to be 109° 28′ and 70° 32′ respectively.

By the very intricate calculation of König, it was determined that the angles for such a purpose should be 109° 26′ and 70° 34′. Here was a wonderful coincidence! the bees and the mathematicians differed by the small discrepancy of two minutes of a degree, or $\frac{1}{10,800}$th part of a circle, an infinitesimal space in so small a thing as a bee-cell.

Were the bees by this minute fraction at fault? or did the geometrician err? We shall see.

Maclaurin, the Scotch mathematician, was not satisfied with this explanation, and applied himself to a fresh and careful investigation of the question. He showed that, owing to a slight misprint in the logarithmic tables, the result previously obtained was erroneous to the exact amount of two minutes! So that the bees were in the right, even to this infinitesimal fraction, and the mathematicians wrong.*

What does this mean? Why, simply, that the Creator has chosen to endow the bees with an instinct so wonderful, that their work is actually perfection itself, and no man could imitate it with exactitude, even though his highly intellectual powers were aided by the most delicate instruments.

* *Lord Brougham* more than once specially notices this interesting fact.

Now mark, that what would take the apprenticeship of a lifetime for man to do, these bees do without any teaching at all; for only a few hours after their transformation to perfect insects they commence their labour.

And this intuitive knowledge and skill is not optional; they have no power to make their cells otherwise, and herein instinct differs from reason. The former is a special endowment for a special purpose, without any free will; the latter prompts to different courses of action, according to different circumstances. These special instincts which cause the bees to make their cells perfect hexagons—the sparrows to build their nests with straw, hay, or leaves, and the swallows to construct theirs with mud; the beavers to build a dam, the rabbits to burrow in the ground—are all proofs of the creation of separate species. For even if by plausible reasoning it could apparently be shown that their bodies were evolved from some common origin, it would puzzle the most learned Darwinian to demonstrate how the bee became possessed of such surpassing mathematical skill. But by following the simple words of Revelation, that each was created after its kind, we can conceive, even if we cannot perfectly understand, their wondrous origin.

The bee seems also to be endowed with an amount of reason, as the following story will show:—

In 1806 Huber the elder stated that death's-head moths abounded, and that greedy of honey they entered the hives and broke all the combs with their great bodies. The bees were frightened and did not know what to do, for they had never before had to contend with such an enemy. After apparently consulting together, they set to work to raise a thick bulwark of wax at the entrance of all the hives in the neighbourhood, leaving a small hole in the centre only just big enough for a single bee to crawl through. The greedy moths, not possessing offensive weapons, flew fluttering[illegible]

against the obstacle, but could not enter. After two or three years the enemy returned in greater force, and immediately the bees shut the openings of the hives as before. Here they acted according to the exigencies of the circumstances, and must, therefore, have an amount of reason besides instinct.

So very much could be said about these wise insects, that I am almost afraid of being tempted to take up too much space in relating all I have read and heard of them.

I must, however, just notice one more very interesting particular. When bees enter a hive for the first time, they examine every part of it, and if there should be any chinks or holes they immediately set to work to cover them over with a substance obtained from different trees, such as the poplar, birch, and willow, and called by the ancients propolis or bee-glue.

This substance is far more durable than wax, and will better resist the weather, being of a resinous nature. Well, it happened once that an ill-fated snail crept into a hive. No sooner did the bees perceive this than they attacked it on all sides, and stung it to death; but what to do with it then at first puzzled them, for they could not carry so heavy a burden, and they knew intuitively that noxious odours would arise from it on the commencement of putrefaction. Marvellous to relate, they set to work to manufacture and collect a quantity of this propolis, and covered the snail entirely, and so hermetically sealed it up that no effluvia whatever could escape.

These instances of special endowments might be multiplied almost indefinitely, but I must give you just one more striking illustration. The larva of the female Stag-beetle makes for herself a hole exactly her own size, in which to bury herself in preparation for her final change; but the male makes one as long again as himself, because when he emerges *from the larval* state and becomes a beetle, he will have horns

as long as his body, which the female will not. But how could he know this? Under what conceivable impulse, except a Divinely implanted one, could the larva of the Stag-beetle have known the necessity of making this longer hole? He certainly could have had no *inherited* experience for what is really a prophetic action.

Could this foresight of the Stag-beetle, and cell-building instinct of the Bee, think you, be brought about by Evolution or Natural Selection? Nay, nay! we must continually come back to our Biblical story, and feel assured that each species was designed and created with separate and special gifts for separate and special missions.

Before closing this chapter, I must refer to a most interesting book lately issued by Dr. Darwin upon

EARTH-WORMS,

and I think every one must be intensely pleased to find that these slimy things, which many of us have hitherto looked upon with aversion, have an important part to play in the economy of Nature. So far from being baneful and useless, we now find that they are among the best friends of the agriculturist and gardener, and in fact neither of them could do without this humble creature, for the bulk of the humus or vegetable mould of our gardens and fields is mainly their manufacture, and goes perpetually through and through their organs to be fitted and perfected for fertilizing the soil.

The *Daily Telegraph*, in reviewing this admirable work, says that "the most assiduous and wealthy farmer does not lavish half as much nourishment upon his crops as the earth-worms, which, in many parts of the British Isles, make and bring to the surface of each acre of land ten tons or more of fine rich mould yearly." It will be remembered that, when treating of the corals, I mentioned how carefully and successfully Darwin had studied those wondrous creatures, which build

atolls, islands, and ocean kingdoms; and yet he seems inclined to rank earth-worms higher in the scale of constructive agencies, for by perpetually consuming decayed leaves and small particles of soil they disintegrate and renew the whole face of our Earth.

Their castings, hardly noticed, alter invisibly the contour of a whole country, covering up rocks and stones with a useful mould, whilst they remove decaying leaves and facilitate the germination of seeds. This great naturalist sums up all by saying that—

"It may be doubted whether there are many other animals which have played so important a part in the history of the world as have these lowly-organized creatures."

We can scarcely find words sufficiently strong to express our gratitude to Dr. Darwin* for having thus shown the usefulness of a creature hitherto supposed to be sent to punish rather than to bless us. How many, many times do we hear people say, Whatever is the good of such-and-such an animal? and God's wisdom and benevolence have often been called in question; but here is the able and cogent reply, and we must never again doubt the usefulness of any creature, however objectionable it may appear. If Charles Darwin had never done anything else than thus patiently to have studied the habits and uses of the Earth-worm, he would have immortalized his name; for he has established beyond all question that the handiwork of the wise and benevolent Creator is all very good.

* Since my first edition appeared we have had to mourn the loss of this great naturalist, and most sincere was the respect paid to his memory when he was laid to rest with the good, the great, and the wise, within the walls of our venerable Abbey of Westminster.

CHAPTER X.

"And the Lord God planted a Garden."

In an early chapter I mentioned that the fruit-trees and flowering plants of the Devonian and Carboniferous periods were of a much lower order than those which appeared later on. It seems, however, that as early as the Lower Miocene period edible fruits and some flowers existed; for Lyell gives an account of the grape-stones of two species of vine, and the leaves of two species of fig, being found in the Bovey lignite, and also mentions that two species of water-lily, and some oak and laurel leaves, had been found in the same strata. Does this affect the statement at the head of this chapter, that a garden was specially planted for man's enjoyment? Certainly not; for not a word is said about there being no fruit-trees or flowers before, but simply that now flowers and fruit-trees of a high class were created—"*Out of the ground made the Lord God to grow every tree that is pleasant to the sight, and good for food,*" that is, having beautiful blossoms and foliage to delight the eye, and bearing delicious and wholesome fruit.

Now, what does Science say? Let me again quote Agassiz, for I attach much importance to the opinion of so great a man, the condensed substance of which is as follows:—

The true grasses, such as the corn-bearing plants of the agriculturist, which form the staple article of human food, and the humbler variety of the same order, which furnishes sustenance

for grazing animals, did not appear until a short time before man, and, in fact, scarcely appear in the fossil state at all.

All the various orders of fruit-trees, such as the apple, the pear, the quince, the cherry, the plum, the peach, the apricot, the nectarine, the almond, the raspberry, the strawberry, and the various bramble-berries, together with all the roses and potentillas, were introduced only a short time previous to the human race.

Some of these grasses and fruit-trees mentioned by Agassiz have been found much earlier than he says, but on the whole he is correct. Moses is therefore again right in the fourteenth event, for it must be noticed that edible fruit-trees preceded him, for he is told that the herbs and fruit-trees then existing should be given him for meat, and this lovely garden was an addition, planted by God's own hand for Adam's delectation:—

"In this pleasant soil,
This far more pleasant garden God ordain'd;
Out of the fertile ground He caused to grow
All trees of noblest kind for sight, smell, taste
And all amid them stood the tree of life,
High eminent, blooming ambrosial fruit
Of vegetable gold.
Southward through Eden went a river large,
* * * * *
* from that sapphire fount the crisped brooks,
Rolling on orient pearl and sands of gold,
With mazy error under pendent shades
Ran nectar, visiting each plant, and fed
Flow'rs worthy of Paradise, which not nice art
In beds and curious knots, but Nature boon
Pour'd forth profuse on hill, and dale, and plain;
Both where the morning sun first warmly smote
The open field, and where the unpierced shade
Imbrown'd the noontide bow'rs. Thus was this place
A happy rural seat of various view;
Groves whose rich trees wept od'rous gums and balm,
Others whose fruit burnish'd with golden rind
Hung amiable; Hesperian fables true,
If true, here only, and of delicious taste.
Betwixt them lawns or level downs, and flocks

Grazing the tender herb, were interposed,
Or palmy hillock; or the flow'ry lap
Of some irriguous valley spread her store,
Flow'rs of all hue, and without thorn the rose.
Another side, umbrageous grots and caves,
Of cool recess, o'er which the mantling vine
Lays forth her purple grape, and gently creeps
Luxuriant: meanwhile murm'ring waters fall
Down the slope hills, dispersed, or in a lake,
That to the fringèd bank with myrtle crown'd
Her crystal mirror holds, unite their streams.
The birds their choir apply; airs, vernal airs,
Breathing the smell of field and grove, attune
The trembling leaves, while universal Pan,
Knit with the Graces and the Hours in dance,
Led on th' eternal spring."

(*Par. Lost*, bk. iv., 216.)

Such is Milton's description of this delightful garden in which the sinless beauteous pair first dwelt, where they walked and talked with God—

"Godlike erect, with native honour clad,
The image of their glorious Maker,
Adam, the goodliest man of men since born
His sons; the fairest of her daughters, Eve."

How much I should like to write some pages upon the finest trees of this garden, and descant for a short time upon their charming variety and their delicious fruits! But I fear I must only devote a little space to those other special gifts of a beneficent Creator, namely,

FLOWERS,

to which, in addition to their loveliness, *fragrance* has been added; and that we may appreciate and enjoy their delightful perfumes, the most delicate organs have been bestowed upon us.

Other animals may have the sense of smell far more acutely than ourselves, but they do not appear, as a rule, to enjoy pleasant scents. The dog, for instance, seems to revel in disagreeable odours, while it takes but little notice

Upwards He ascended, and "the morning stars sang for joy" as the glorious host passed by them; and when the heavenly gates appeared in sight, another song, still louder, still more triumphant, rent the sky:—

> "Open, ye everlasting gates;
> Open, ye heavens, your living doors; let in
> The Great Creator, from His work return'd
> Magnificent, His six days' work, a world;
> Open, and henceforth oft; for God will deign
> To visit oft the dwellings of just men
> Delighted, and with frequent intercourse
> Thither will send His wingéd messengers
> On errands of supernal grace."

I think the statement that man was made in the Divine image is intended to be more literal than we generally suppose; for, judging from what we read throughout the Scriptures, it seems very clear that our Lord, as well as the angels, had a bodily form similar to that of man, only far more spiritual and far more glorious, but which, however, is invisible to man unless special capabilities of sight are given him, like that experienced by Elisha's servant when, in answer to the prophet's prayer, he saw the heavenly host surrounding the city of Dothan.

It scarcely requires any argument to prove that forms can and do exist of which we are not cognisant with our natural sight; for if we take up a glass of water it appears perfectly transparent and clear to our unassisted eyes; but on placing a drop of that water under the microscope, we instantly see many beautiful and wondrous forms of living creatures, and on applying a stronger power a still greater number of them will burst upon our view; and if we go on increasing the power many thousands of times, we find we have not reached the limit of these minute organisms.

Again, we cannot see the air, though it is composed of atoms of matter whose weight is such that the pressure upon *every square* inch amounts to fifteen pounds, and upon the

"The barge she sat in, like a burnish'd throne,
Burn'd on the water; the poop was beaten gold;
Purple the sails, and so perfumed, that
The winds were love-sick with them; the oars were silver,
Which to the tune of flutes kept stroke, and made
The water which they beat to follow faster,
As amorous of their strokes.

* * * * *

From the barge
A strange invisible perfume hits the sense
Of the adjacent wharfs. The city cast
Her people out upon her; and Antony,
Enthron'd i' the market place, did sit alone,
Whistling to the air; which, but for vacancy,
Had gone to gaze on Cleopatra too."

(*Ant. and Cleop.*, ii. 2.)

Fig. 84.—Frankincense (*Boswellia thurifera*).

The Jews also cultivated flowers, and not only enjoyed the fragrance, but were encouraged by their lawgiver, and by God Himself, in so refined a taste; and their religious ceremonies were, as we know, accompanied with the burning of odoriferous drugs.

The directions they received for making the holy anointing oil are very remarkable:—"Take thou also unto thee principal spices, of pure myrrh five hundred shekels, and of sweet cinnamon half so much, even two hundred and fifty shekels, and of sweet calamus two hundred and fifty shekels, and of cassia five hundred shekels, after the shekel of the sanctuary, and of olive oil an hin: and thou shalt make it an oil of holy ointment, an ointment compound after the art of the apothecary: it shall be a holy anointing oil" (Exod. xxx. 23—25).

Fig. 85.—Spikenard (*Valeriana jatamansi*).

Frankincense (Fig. 84), which was much used by the ancient Jews, was an exudation from a tree called *Boswellia thurifera*, principally found in Yemen, a part of Arabia. In the time of Pliny it was only to be procured from that country, and he tells many marvellous stories respecting its mode of collection and the difficulties in obtaining it. It has, however, since been discovered in some of the mountainous parts of India.

Spikenard (Fig. 85), Sir William Jones says, was probably a plant of the Valerianic order, possessing much

fragrance, and so called from its having a stem which somewhat resembles the tail of an ermine. Sometimes this word was used by the ancients as a generic name for every kind of perfume.

The burning of perfumes as incense was also specially ordered as a Jewish rite, and the high priest was directed to offer them daily upon the altar. (Fig. 86.)

Fig. 86.—The Jewish High Priest Burning Incense.

From the ancient records, as well as from the sculptures and tablets now in our possession, we find that the Assyrians were also great lovers of flowers, and cultivated them with much care. Foremost, indeed, among all the marvels of Babylon were the hanging gardens, which Nebuchadnezzar erected to please his wife Amytes, daughter of Astyanax,

King of the Medes. These gardens were about three acres in extent, and raised one above the other upon columns some 40 feet high, until the last parterre overlooked the top of the city walls, 300 feet in height.

"Within the walls was raised a lofty mound,
Where flowers and aromatic shrubs adorned
The pensile garden. For Nebassar's queen,
Fatigued with Babylonia's level plains,
Sighed for her Median home, where Nature's hand
Had scooped the vales and clothed the mountain side
With many a verdant wood; nor long she pined,
Till that uxorious monarch called on Art
To rival Nature's sweet variety.
Forthwith two hundred thousand slaves uprear'd
This hill—egregious work! rich fruits o'erhang
The sloping vales, and odorous shrubs entwine
Their undulating branches."

Fig. 87.—Roman Ladies using Perfumes.

There, by the side of the lofty cedar, grew the mournful cypress and the elegant mimosa; but the favourite resort of the queen was the bower where bloomed the rose and the lily, vying with each other in beauty and fragrance.

That the Greeks and Romans were equally fond of flowers is shown by an abundance of beautiful poetic descriptions amongst the classic authors; and a full account of this will *be found in* Rimmel's excellent work on the History of

Perfumes, to which I am indebted for some valuable and highly interesting information.

I must, however, give you a quotation from Xenophanes' description of a Grecian entertainment:—

> "The ground is swept and the triclinium clear,
> The hands are purified, the goblets, too,
> Well rinsed; each guest upon his forehead bears
> A wreathèd flow'ry crown; from slender vase
> A willing youth presents to each in turn
> A sweet and costly perfume; while the bowl,
> Emblem of joy and social mirth, stands by,
> Fill'd to the brim; another pours out wine
> Of most delicious flavour, breathing round
> Fragrance of flowers, and honey newly made,
> So grateful to the sense, that none refuse;
> While odoriferous gums fill all the room.
> Water is served too, cold and fresh and clear;
> Bread, saffron-tinged, that looks like beams of gold.
> The board is gaily spread with honey pure
> And savoury cheese. The altar, too, which stands
> Full in the centre, crown'd with flow'ry wreaths;
> The house resounds with music and with song."

The indulgence in these luxuries would, I am sure, be condemned by many, and the utter decay of both Greece and Rome is pointed at as evidence of the national ruin attendant upon such a mode of living. I think that such writers and speakers err greatly, for it was not the enjoyment of these refined pleasures which destroyed those countries, but their misuse, accompanied with effeminacy, cruelty, and oppression. Because of their misuse many good men afterwards most mistakenly associated God's gifts with men's follies; and there were even some who were not favourable to the cultivation of these lovely additions to God's world, or at any rate objected to their use at public and private festivals, and strictly forbad their presence at all religious ceremonies. I am glad, however, that different opinions prevail now, and that flowers are considered necessary addenda to every feast, and are used to decorate the cradle and adorn the tomb.

Do they not in this latter case alleviate the gloomy shades of death, and give an opportunity for loving hearts to show one more token of affection and esteem in these emblems of a brighter and more beautiful world beyond the grave?

Who is there that did not appreciate the tender gentleness of our much-beloved Queen when she placed with her own hands a wreath upon the coffin of her departed Minister, Lord Beaconsfield? On another occasion, her Ambassador, in her name, placed a floral token on the casquet which contained the remains of the much-honoured American President, General Garfield, so cruelly cut down in his useful career.

At the funeral of Sir Edwin Landseer I was present in St. Paul's, sitting with the venerable George Cruikshank near to the bier, and read on a card attached to one of the most beautiful wreaths, "From Queen Victoria, as a mark of her esteem."

When Livingstone was lowered into his honourable grave in Westminster Abbey, I looked into it and saw a similar Royal token; and my inward exclamation was, "How sincerely does our Sovereign love her people!" And the prayer ascended from my heart, "God bless our noble Queen!"

Much, very much, good has come to us from these numerous incentives to the growth of flowers. I think we now excel all other nations in the beauty and variety of our floral productions. To my mind nothing can surpass the exhibition at the Royal Botanical Gardens on *fête* days, and each year seems to add hundreds of fresh varieties of flowers still more beautiful in form and colour. And let me here again refer to this law of variation, which enables man to add year by year to his enjoyment something new, something striking, something lovely. But then, as I said before, cultivation produces only endless varieties of the same species: a rose is a rose still, although its colours may be changed ten thousand times, *and its* petals assume as many thousand forms. I cannot,

and I will not, grant that this proves the doctrines of Evolution and Natural Selection, but rather that it is one of the wise and beneficent arrangements of the Creator that man should have it in his power to multiply the sources for refined gratification. For by using his skill in finding out the secrets of Nature, and patiently following up his discoveries, he is amply rewarded for all his toil, for all his care.

I look upon flowers as the special gift of our Heavenly Father: the creation of trees for our timber, of grass for our cattle, and of corn for our bread, were all provisions for our necessities, but it was His loving hand alone which beautified this world with these additions to our happiness, which raise us above the world and link us to heaven.

CHAPTER XI.

"So God created Man in his own Image."

MANY learned men have already written volumes upon the important and deeply-interesting subject of man's advent; they differ, however, greatly from one another. It would, therefore, be presumptuous for any one at present to hold or enunciate dogmatic opinions in reference to it. But, as much knowledge is daily being gained upon the origin and antiquity of the human race, I think we may look ere long for more definite and reliable data that will furnish us with the means of arriving at correct conclusions.

Whatever those conclusions may be, I do not fear that they will be contrary to our Biblical statement, which to me is so truly sublime as to call forth an amount of reverence and even of awe.

It would seem as though God called together all the heavenly host to witness His last great act of creation, and that He proclaimed to them all the high endowments which He intended to bestow upon this masterpiece of His wisdom, power, and skill. We can suppose that the Archangel Gabriel had been sent forth to summon the host of glorious beings, who, assembling together, stood rank upon rank in all their Godlike nobleness and beauty, in which they had been created probably ages before this world's history had commenced. And by the side of the Almighty stood His well-beloved Son, who was daily His delight, rejoicing always before Him, from the beginning or ever the world was. *Looking* round upon this august and Divine assemblage,

God said, "*Let us make man in our image, after our likeness: and let them have dominion over the fish of the sea, and over the cattle, and over all the Earth.*" At once from all the angels and archangels burst forth a shout of praise—

> "Follow'd with acclamation and the sound
> Symphonious of ten thousand harps, that tuned
> Angelic harmonies."

And then the whole vault of heaven reverberated with the song of "Glory to God in the highest!"

Immediately from the dust of the ground sprang forth a Godlike form, which, perfect in limb, erect in stature, noble in mien, enshrined a soul immortal, a spark of Divinity breathed into it by God Himself. And thus was Man created.

And now another song breaks forth from the heavenly host, accompanied with ten thousand times ten thousand harps, attuned to the sweetest, noblest, and most triumphant melodies—

> "Thrice happy Men,
> And sons of Men, whom God hath thus advanced,
> Created in His image, there to dwell
> And worship Him; and in reward to rule
> Over His works, on earth, in sea, or air,
> And multiply a race of worshippers
> Holy and just! Thrice happy, if they know
> Their happiness, and persevere upright!"

This song died away, then God ceased from all His work and the creation of the world was completed.

> "Here finished He, and all that He had made
> View'd, and behold all was entirely good;
> So even and morn accomplish'd the sixth day:
> Yet not till the Creator from His work
> Desisting, though unwearied, up return'd,
> Up to the heav'n of heav'ns, His high abode,
> Thence to behold this new-created world,
> Th' addition of His empire, how it show'd
> In prospect from His throne, how good, how fair,
> Answering His great idea."

Upwards He ascended, and "the morning stars sang for joy" as the glorious host passed by them; and when the heavenly gates appeared in sight, another song, still louder, still more triumphant, rent the sky:—

> "Open, ye everlasting gates;
> Open, ye heavens, your living doors; let in
> The Great Creator, from His work return'd
> Magnificent, His six days' work, a world;
> Open, and henceforth oft; for God will deign
> To visit oft the dwellings of just men
> Delighted, and with frequent intercourse
> Thither will send His wingéd messengers
> On errands of supernal grace."

I think the statement that man was made in the Divine image is intended to be more literal than we generally suppose; for, judging from what we read throughout the Scriptures, it seems very clear that our Lord, as well as the angels, had a bodily form similar to that of man, only far more spiritual and far more glorious, but which, however, is invisible to man unless special capabilities of sight are given him, like that experienced by Elisha's servant when, in answer to the prophet's prayer, he saw the heavenly host surrounding the city of Dothan.

It scarcely requires any argument to prove that forms can and do exist of which we are not cognisant with our natural sight; for if we take up a glass of water it appears perfectly transparent and clear to our unassisted eyes; but on placing a drop of that water under the microscope, we instantly see many beautiful and wondrous forms of living creatures, and on applying a stronger power a still greater number of them will burst upon our view; and if we go on increasing the power many thousands of times, we find we have not reached the limit of these minute organisms.

Again, we cannot see the air, though it is composed of atoms of matter whose weight is such that the pressure upon *every square* inch amounts to fifteen pounds, and upon the

body of an ordinary-sized man some fourteen tons; but, notwithstanding this, the optician could not construct a microscope sufficiently powerful to render these atoms visible.

Well, then, if there be many things composed of matter which we can analyse and weigh, and yet not see, why should there not be beautiful æthereal beings also invisible to us? I think it highly probable that there are, and that man's bodily form has been fashioned after their likeness. It is worthy of note that on several occasions in the Old Testament it is mentioned that our Lord appeared in such a form. He did so to Abraham on the plains of Mamre, and although the patriarch at first thought Him a distinguished stranger, he soon discovered His Divinity, and, bowing with his face to the ground, most humbly and most earnestly pleaded for the people of Sodom. To Joshua He appeared as "Captain of the host of the Lord," and commanded Israel's leader to loose his shoes from off his feet, as His presence rendered even the place on which he stood holy! Joshua reverently bowed down before Him and worshipped Him; this was direct evidence of His being the Second Person in the Trinity, for we know that angels and glorified spirits would never accept either of adoration or worship. Nebuchadnezzar's eyes were opened to see Him in the midst of the fiery furnace, and with astonishment he exclaimed, "Lo, I see four men loose, walking in the midst of the fire, and they have no hurt; and the form of the fourth is like the *Son of God.*"

In all these cases it will be noticed that our Lord appeared in the form of a man. It seems also that angels always appeared in that form. Thus, when Manoah's wife was relating to her husband one of these angelic visits, she said, "A *man* of God came unto me, and his countenance was like the countenance of an angel, very terrible." But notice that when, in answer to Manoah's prayer, the angel appeared a second time, he said, "Though thou detain me, I will not eat of

thy bread: and if thou wilt offer a burnt offering, thou must offer it unto the Lord;" thus forbidding Manoah to worship him in any way.

Another remarkable instance is that when Daniel was praying, the *man* Gabriel, who had been caused to fly swiftly, touched him about the time of the evening oblation, and said, "O Daniel, I am now come forth to give thee skill and understanding. At the beginning of thy supplications the commandment came forth, and I am come to show *thee;* for thou art greatly beloved."

I feel that I must notice one more instance of a heavenly being conversing with a man, and it is that of the angel who showed St. John the wondrous visions of the Revelation, and who so emphatically forbade him to worship him. The verses read thus:—"And I John saw these things, and heard them. And when I had heard and seen, I fell down to worship before the feet of the angel which shewed me these things. Then saith he unto me, See thou do it not: for I am thy fellow-servant, and of thy brethren the prophets, and of them which keep the sayings of this book: worship God."

Thus this angel intimated to St. John that it would be sinful for him even to bow before him. One could almost imagine it pardonable to fall down with reverence before so glorious a being; but what excuse can there be for the worship of either saints or angels when there is no manifestation of their presence?

That glorified spirits also have a form similar to our own is alike certain; for on the Mount of Transfiguration the Apostles saw two *men* in shining garments who had come down to converse with Christ. One of these was Moses, who had died, and the other was Elias, who was taken up to heaven without his spirit having been separated from his body. This account is also deeply interesting, as it shows that we shall

all know each other in heaven; for the apostles were intuitively aware that those two great prophets, whom they had never seen, were conversing with our Lord.

From all this I think it is very clear that even man's bodily form is Divine; and, therefore, all wanton injuries, whether self-inflicted or imposed on others, are grievous sins. Drunkenness, gluttony, and impurity, which impair and ultimately ruin all the vital functions, are therefore double sins, because they are not only breaches of God's law, but they mar and pollute the temple of the soul.

I am sure if a man would only consider a little more the Divinity of his human form, and would remember that God has indeed created him in His own image, the thought would so elevate and refine him that he would feel it his duty to glorify God in his body as well as in his spirit.

And this spirit, what is it? How shall I attempt to define the indefinable?

Referring to the words of Revelation, how much do they imply! "*God breathed into his nostrils the breath of life, and man became a living soul.*" It can only mean that God has implanted within this body a portion of His own Spirit, which constitutes *Man's Individuality,* united indeed to the animal frame by mysterious bonds, and yet quite distinct from it in nature and in essence.

Of the existence of this inward Soul are we not hourly conscious? Is not our personality one of the things most dear to us? for when we sometimes say that we should like to be such-and-such a man, we mean that we should like to be in his position; and the meanest beggar would not wish to lose his identity even to be a king, though he would like his rags to be changed for robes of silk. The greatest sufferer would not desire to be another man in full health, but would ardently wish that his own body might be rendered strong and well.

Again, how instinctively do we shrink from the idea of annihilation, even though it should be the Brahminical doctrine of the re-absorption of the soul into that of the Deity! which most clearly indicates that we prize our personality.

And, advancing a step farther, are we not conscious that, notwithstanding the daily and hourly changes that are taking place in our bodies, our souls remain the same? Do not our motives for action, our affections, our particular tastes, our special gifts and predilections, and all the other qualities and peculiarities of our inward selves, continue unaltered?

Surely this is an evidence also of our immortality, which Revelation confirms by telling us that death shall really be only a commencement of a higher and a nobler state, when, freed from the trammels of matter, we shall be capable of attaining to a perfect knowledge of the whole of God's wondrous works, and that we shall be able then to understand all the harmonious arrangements of the Universe. What is inexplicable to us now shall then be most clear, and an eternity will not diminish our intense admiration of the infinite design, beauty, and perfection of all creation.

And does Science confirm this account of man's advent upon the Earth? Does it nullify the word "created," and substitute "evolved"? I think not, unless it be that the form evolved was long before involved in the Creator's will.

Fossil apes are found in abundance. Even as far back as the Miocene period such animals lived, and continue to do so in all respects unchanged; but the infinite number of links required to connect man with so mean an origin has not been found. On the other hand, wherever human remains have been discovered they show the same high-class type of head, and a skeleton indicating a form as perfect and as noble as that of the present race. I say in whatever strata *human remains* have been discovered, because some striking

facts have come out in reference to the time of man's first appearance, which seem to place the date much farther back than has been generally received. This, however, will not affect the authenticity of Holy Writ, for there are no dates mentioned in the Bible. It is only the commentators and the compilers of chronological systems who have put forward the 6,000 years; but so completely has it taken hold of the human mind, that a little while ago it would have been thought by many persons the direst heresy to mention a longer period.

Human remains have been found in strata which would seem to make man contemporary with the Mammoth and other wild beasts which have long since passed away. In reference to this, Hugh Miller thought, with many others, that such remains had got mixed with the bones of animals of ancient times from men burying their dead in caves and other places where such bones would abound; or that they might have got washed into such positions by great floods; or, lastly, that by men falling down crevasses their remains might have become covered over with the *débris* of surrounding strata, and thus appear to have been buried there ages ago.

Figuier, and other eminent writers, endeavour to meet all these objections, and to show that the various implements found with the bones indicate most clearly that man existed many thousands of years before the time fixed by our chronologists. Lyell also held a similar opinion.

There are others who think differently from both Hugh Miller and Lyell, and say that a primitive race of men might have existed long before Adam, but that they were destroyed by some sudden glacial condition of the districts inhabited by them, or by some great convulsion similar to the Noachian Deluge, and that the Adamic creation took place afterwards.

Whether any or all of these theories be more or less correct, it matters not, for should they be so they would not affect the

question I am discussing; since none of them disproves that man was created last of all, as described by Moses; or my former statement, that since his advent no additional species, either of plants or animals, have appeared upon the Earth—all this shows the Sabbatical rest after man's creation.

I contend that it is our duty to study carefully all that Science teaches us, and to weigh well each discovery, so that our knowledge may become more and more perfect in reference to the laws and operations of Nature. I am inclined to think that the first chapter of Genesis gives the general account of man's creation, and the second the special creation of Adam as the ancestor of our Lord, and that he was endowed with a high amount of knowledge and refinement. Should cavillers carp at this, let me point them again to the bee with its perfect mathematical endowments. Could not, then, the Great Creator bestow upon Adam a large amount of intuitive knowledge and much refinement? Yea, more, I fully believe that He made him also acquainted with not a few of the arts, and probably many of the sciences. That Adam understood botany there can be no doubt, in order that he might appreciate and enjoy the floral and sylvan pleasures of his garden home; and that zoology was also known to him is equally evident, for he gave to all the animals names according to their natures, and by those names were they called. Is it not also most likely that when God walked and talked with him in that paradise, He would explain to him what were all those bright and sparkling luminaries in the vault of heaven?

Language our first parents certainly had, and there are not a few evidences also that writing was equally known to them; and as, according to Gen. iv. 21, &c., they were both alive when Jubal excelled in playing the harp and organ, in all probability they taught him the music which they had learned in Eden.

I certainly cannot believe that Adam was an untutored savage; and if ethnologists insist upon asserting that the rude implements found with human bones are evidences of his uncivilised condition, then I must go back to my former proposition, that the record of the first chapter of Genesis relates to these primeval men, and the second to the ancestor of our Saviour and ourselves. And with regard to those contemporaries of the Mammoth, let me say that ignorance of the arts would not at all imply that they had savage and brutal minds—the result, I believe, only of base and degrading habits; for I have often noticed that the lowest type of criminals, bred in the filthy slums of East London, have faces and features as debased-looking as the worst African tribes, differing from them only in the colour of their skins.

Figuier, in his work upon "Primeval Man," entertains the same opinion, and says that, judging from their skeletons, these men were a handsome race, and with skulls indicating intellect of no mean kind. One thing is perfectly certain, that as far as history carries us back, man was always quite as intellectual as he is now. It is true that the acquirement of scientific facts was slow till within the last few years; but all must admit that the ancient Egyptian, Hebrew, Assyrian, Greek, and Roman were quite equal and often superior to the men of our own times; that Cæsar, Homer, Nebuchadnezzar, Isaiah, Solomon, Pharaoh, and Moses are certainly not now surpassed intellectually.

A short time ago I was not a little interested by a suggestion that Solomon might have been the originator of the problems attributed to Euclid, who has for some time past been thought the compiler only of the work which bears his name. I confess that as a boy I was much struck with the amount of genius required to invent such figures, enunciations, and proofs; and I imagined that nothing short of inspiration could have accomplished it. Would it not be

extremely interesting if we should be able to trace the foundation of geometry to him upon whom the gift of special wisdom was bestowed? That Solomon was a most skilful architect we know for a certainty; and also that he was a naturalist is equally evident, for did he not speak "*of trees, from the cedar that is in Lebanon even unto the hyssop that springeth out of the wall*"? It may be that amongst the ruins of buried-up cities, the exhumation of which is almost daily adding to our knowledge of Biblical characters, we shall ere long find something more about Solomon.

You will thus see from all I have said that I consider the Darwinian theory in reference to man quite untenable. How far superior, and how much more reasonable, seems the theory that from the first God intended man to be the climax and finish of His creative acts; and that whilst He was causing all things to tend towards this grand consummation of His wisdom and power, He had before Him the model and plan of man's bodily structure and mental endowments! And it is delightful to find that Divine writers and some of our greatest philosophers agree upon this point. Let us take first the words of the Psalmist:—

"*In thy book all my members were written, which in continuance were fashioned, when as yet there was none of them.*" (Ps. cxxxix. 16.)

Here we have the Deity described as definitely prearranging the very form which the human organs were to assume before they even existed: a form, observe, not existing in embryo, not in the protoplasm, not in the ascidian, not in the fish, not in the saurian, not in the ape, but a distinct arrangement of muscles, bones, ligaments, nerves, brain! comprising altogether a temple meet for the immortal and Divine principle which was to constitute the real *man*.

Now let us take the statement of Professor Owen, supreme in his own special walk as a comparative anatomist, who says :—

"The recognition of an ideal Exemplar for the Vertebrated animals proves that the knowledge of such a being as Man must have existed before Man appeared. For the Divine mind which planned the Archetype also foreknew all its modifications." *

Could anything be more beautiful or more comprehensive than this short sentence? It is indeed a *multum in parvo*, and greatly enriches my pages.

And now we will hear what Agassiz says, whose deep study of geologic existences was more extended and minute, at least in the ichthyic department, than that of any other man. He concludes his work on the "Principles of Zoology" with these words :—

"It is evident that there is a manifest progress in the succession of beings on the surface of the Earth. This progress consists in an increasing similarity to the living fauna, and among the Vertebrates, especially in their increasing resemblance to man. But this connection is not the consequence of a direct lineage between the faunas of different ages. There is nothing like parental descent connecting them. The fishes of the Palæozoic age are in no respect the ancestors of the reptiles of the Secondary age, nor does man descend from the mammals which preceded him in the Tertiary age. The link by which they are connected is of a higher and immaterial nature; and their connection is to be sought in the view of the Creator Himself, whose aim in forming the Earth, in allowing it to undergo the successive changes which Geology has pointed out, and in creating successively all the different types of animals which have passed away, was to introduce man upon the surface of our globe. Man is the end towards which all the animal creation has tended, from the first appearance of the first Palæozoic fishes."

The marvellous structure of man's bodily frame, and its superiority to that of all other animals, is so remarkable that

* Owen on the Nature of Limbs, p. 85. (1846.)

I intended at first to describe several of the most important organs, but I fear that I must confine myself to the nervous system.

The Brain

consists of several distinct parts. The principal is the *Cerebrum* (*c*, *c*, Fig. 82), which occupies all the front and upper

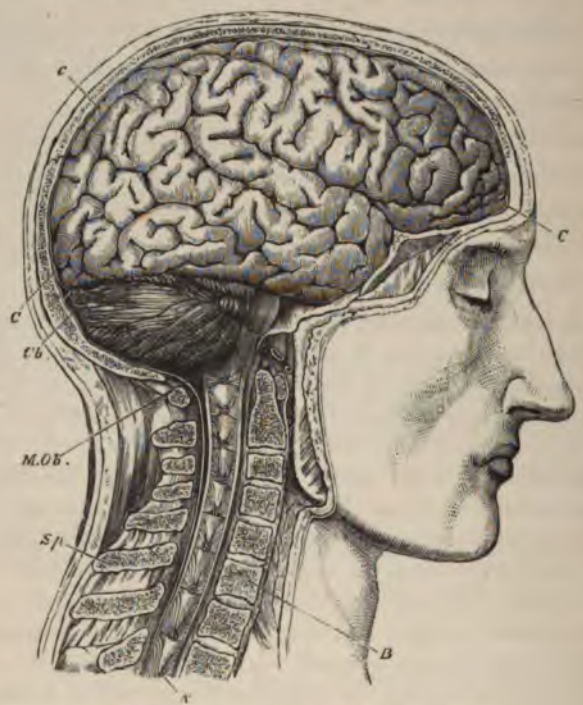


Fig. 82.—Convolutions of the Brain.

part of the skull, and is divided into two halves, or hemispheres, by a membranous partition. Beneath this is another mass, much smaller, but still of considerable size, termed the *Cerebellum* (*cb*), and this also is divided into two parts.

The cerebrum is the largest and most important part of the brain, for it is not only the seat of the sensations, but

also the organ by which we reason upon the ideas that are excited by such sensations, and by which we judge and decide upon our course of action, and then put that decision into practice by issuing a mandate which passes down the spinal column (*sp*) to the muscles, exciting them to action.

This cerebrum increases in size as we ascend the scale of animal life, in proportion to the development of the intelligence and the predominance which it gradually acquires over blind instinct. I need not say that its greatest development is in man, in whom, however, there is much variety both as to its size and quality. The two extremes would be exemplified in a Shakespeare and a Hottentot; but the most degraded savage is infinitely removed from the ape, for however low man may be in the scale of humanity, he is capable of intellectual culture, which no other animal ever is; and therefore, though the Divine spark is indeed very feeble within the savage, still it is there, and can be fostered and fanned into brightness. The noble face and features of our Bard must call forth admiration from every one, and perhaps this has led many people to think that all possessing such a forehead would under favourable circumstances be equally capable of the same intellectual achievements. This, however, would not be the case, for quality as well as quantity of brain is necessary to constitute ability, and of this I have had not a few opportunities of judging.

Two cases occur to my mind which illustrate my meaning. A lad was placed with me who had been born in the West Indies, and had what phrenologists would call a splendid head and forehead; but notwithstanding this he could not master a problem in Euclid, nor even learn correctly a conjugation of a verb. He was not deficient in sense, and I dare say, as his father is a man of property, he will manage to get fairly through the world, not having to play any important part, intellectually or otherwise.

The other lad was from the East Indies, and had what might be thought a small forehead; but the quality of his brain was such that he exceeded all other pupils that ever came under my notice in the quickness with which he acquired knowledge. Scarcely speaking English when he arrived, and knowing nothing of the classics or French, and very little indeed of mathematics, in eighteen months he could read and translate Cicero's "Orations" fluently and accurately. He had also acquired such a perfect knowledge of French that he could converse with Frenchmen in their own tongue, and write original essays in that language. Added to this, he had during the same eighteen months gone through three books of Euclid, the whole of the rules of arithmetic, and had advanced in Algebra to Equations. In another year he passed a University examination, and is now an eminent member of the Bar of India, rising fast to fame and fortune. I think his abilities were such as to render him a brilliant rather than a deep scholar; and it was evident, from his health giving way when studying for his B.A. degree, that his brain could not stand over-pressure.

I would notice, however, that I do not think this great difference could be attributed to the different nationalities of the lads, for soon after another example occurred in which the cases were quite reversed. A most shrewd and sharp boy came from the West Indies, and about the same time one from the East, who acquired every subject with great difficulty. The West Indian is now a clever barrister, but of the East Indian I have heard nothing for some years.*

In Cuvier there was both size and quality, for his brain weighed 64 ounces, and hence he could work for many hours without injury at subjects requiring the deepest thought.

* I should like just to mention here another of my senior boys, Mr. Frank Clark, now in India, who acted as my amanuensis throughout the compilation of this work, and rendered me valuable assistance in the *necessarily large* correspondence.

Abercrombie's was 63 ounces, whereas the general weight of a man's brain is from 48 to 50 ounces, and of a woman's about 44. An idiot's sometimes only weighs 16 ounces.

On examining the brains of clever men, anatomists have found that the convolutions at the top of the cerebrum were more marked and more numerous than in the brains of other men. If, therefore, we could have seen the brains of the two lads I first mentioned, we should have doubtless found that in the first such convolutions were very small both in number and size, and in the second lad well marked and numerous.

Many careful observations have been made in order to ascertain the degree in which the activity of the cerebrum is essential to the maintenance of life; and Dr. Carpenter relates a case where a pigeon was kept alive (if alive it could be called) for some months after the removal of its cerebrum—running when it was pushed, flying when it was thrown into the air, drinking when its beak was plunged into water, swallowing food when it was put into its mouth; though at all other times, when left to itself, appearing like an animal in profound sleep.

So likewise it has been found that the cerebellum, or lower division of the brain, is connected with the powers of motion. Dr. Carpenter says that its size in the different tribes of vertebrated animals bears a pretty close correspondence with the variety and energy of the movements performed by them; being greatest in those animals which require the constant united effort of a large number of muscles to maintain the usual position, whilst it is least in those which require no muscular exertion for this purpose.

Thus in animals that habitually rest and move upon four legs, there is but little occasion for any organ to combine and harmonise the actions of their several muscles, and in them the cerebellum is small. But among the more active predaceous fishes (as the shark); among birds of the most varied

and powerful flight, which not only fly rapidly, but execute the most complicated evolutions in pursuit of their prey with the greatest facility; and among mammals which can maintain the erect position, and use their extremities for other purposes than support and motion, we find the cerebellum of much greater size: whilst in man, who surpasses all other animals in the number and variety of the combinations of muscular movements which he is capable of exercising, it attains the largest dimensions and its greatest complexity of structure.

In all classes of vertebrated animals it has been found that, when the cerebellum was removed, the power of walking, springing, flying, standing, or maintaining the equilibrium of the body, was destroyed. In such cases it did not seem that the animal had in any degree lost voluntary power over its individual muscles, but it could not combine their action for any general movement of the body. The reflex movements, such as those of respiration, pulsation, &c., remained unimpaired.

And now please to look at Fig. 83, and notice that the spinal cord passes down the back, issuing as it were from the base of the brain through the vertebra, from which branch off all the numerous nerves that permeate the whole trunk of the body. And here again we have the same thing occurring of two kinds of brain matter, for the nerves which issue from the spinal cord all possess two sets of roots, one from the anterior portion of the cord, the other from its posterior portion. This was the great discovery of Sir Charles Bell, in 1807, who found that if the spinal cord of an animal were laid bare, and the posterior set of roots touched, acute pain would be produced; whilst if the anterior roots were irritated, violent motions of the muscles supplied by that nerve were occasioned.

These two nerves, of different capabilities, thus marvel-

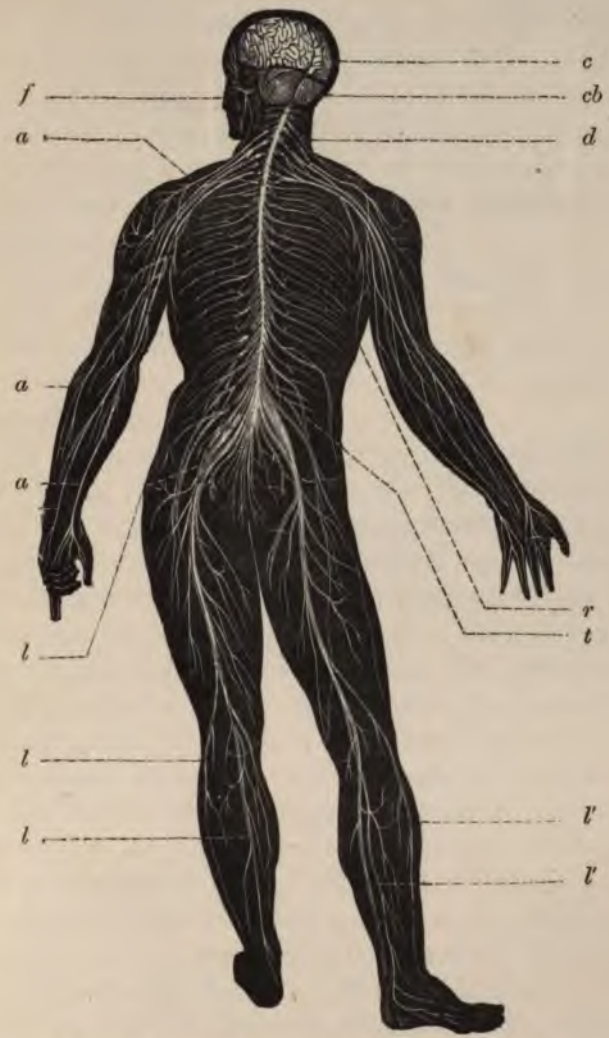


Fig. 83.—Back View of the Nervous System of Man.

c. Cerebrum. *cb*. Cerebellum. *f*. Facial Nerves. *d*. Nerves of the Neck. *a*, *a*, *a*. Nerves of the Arm. *l*, *l*, *l*. Nerves at the back of Leg. *l'*, *l'*. Nerves in the front of Leg. *r* and *t*. Nerves of the Ribs and Loins.

lously united, resemble a silken thread composed of two finer ones spun together; only in the case of the nerves the union is much closer and more complete; so that the tiniest nerve at the finger's end, which the finest-pointed needle would sever, is composed of both kinds of nervous matter. Is not this a wonderful display of wisdom, power, and design? and does it not call forth fresh admiration of the Great Creator's beneficence and power?

We must not regard the brain as the single centre of nervous action, as essential to the maintenance of the life of the body; but we must attribute to the spinal cord no small amount of independent power, which function has been called reflex action.

In reference to this, Dr. Carpenter, in his excellent work on "Animal Physiology," remarks that there is much reason to believe that when we are walking steadily onwards, and the mind is occupied with some train of thought which engrosses its whole attention, the individual movements of the limbs may be kept up by reflex action, while their general direction is guided by visual sensation. And even when the mind is sufficiently on the alert to guide, direct, and control the motions of the limbs, their separate actions appear to be performed without any immediate exertion of the will.

The function of the spinal cord appears to be principally restricted to the performance of movements of this character, and it varies greatly in size and action in different animals. In the lowest fishes the spinal cord seems the principal organ, and the brain an insignificant appendage to it. Hugh Miller says that in birds the brain is three times greater than the spinal cord, and in mammals about four times; whereas in man the brain is twenty-three times greater than the nervous matter in the vertebral column. This remarkable difference is worthy of attention.

THOUGHT.

I will now notice one or two of the intellectual functions of the brain, and will commence with thought; the first advance towards which is the perception of objects, in which the eye and the ear play a most important part. The child distinguishes things before it can call them by their names; it knows its mother before it can utter the words "my mother" or "*ma mère.*"

Remembering the names of objects is, therefore, the second advance in thought, and next would come predicates, or the ideas of qualities and actions. As we advance in education numerous objects are arranged and re-arranged in endless forms; but, however numerous, they would only be enlargements and varieties of combinations of the subject and predicate.

A person who has learned several languages, and who has studied many scientific subjects, has infinitely more objects for thought than one who cannot read or write. A few hundred words would constitute the entire vocabulary of the latter, whereas the former would have tens of thousands of words stored up in his mind, which he could use at his command in many millions of combinations. Now it must follow from this idea that we could have no thought without

MEMORY,

for by it we retain the impression of facts or events, and by recollection recall them.

Doubtless some men possess this faculty in a much higher degree than others, and therefore acquire more knowledge and are the better able to use it. Still it may, like other faculties, be cultivated and greatly improved. But people generally do not seem to think this, for they will be heard to say with *empressement*, "I have such a bad memory;" and

yet they would not think of saying, "I have a very bad judgment."

More frequently than not a bad memory is simply the result of indifference or inattention. One person, for instance, will read a book through once, and be able to give a very fair account of the whole of its contents; whereas another would read it through half-a-dozen times, and know little or nothing about it, because he had allowed his mind to wander, and had not taken the proper interest in the subject. Let me illustrate this by an incident.

There was a cry of "Fire!" and men, women, and children were rushing on towards the spot where the sparks were seen to be ascending to the sky. Fire-engines were dashing through the streets as fast as their high-spirited and well-kept horses could convey them. On turning a corner the terrific scene burst upon the view. The whole of the lower part of a large house was on fire, and the flames were seen to be ascending from floor to floor, darting long tongues of fire out of the windows. Attempts were made to save some of the goods and valuables, but there was little or no chance of doing so, for the fire had reached the roof on one side of the house, and presently that part fell in with a crash. Just then, on the other side of the house, a scream was heard from a top window, and a woman was seen with a child in her arms. She had been so sound asleep that she had not heard the alarm. What was to be done? To enter the house was an impossibility; besides, the stairs were on fire. A cry was raised, "Bring a fire-escape!" and soon some men were seen pushing forward the tall apparatus. But now, alas! the fire had reached the rooms underneath the woman, who was still holding her child in mute despair towards those below. Who will mount the ladder and save them? Without a moment's thought one brave man pushed past the rest and sprang upon the ladder, ascending through fire and smoke; every eye was

fixed intently upon him, and as the glaring light illuminated his face, how deeply was every lineament of his features imprinted upon each mind! He is near the top, and now has reached the helpless pair. He takes them both in his strong arms, and descends with the precious burden, the monster crowd cheering him on. At last he reaches the ground in safety, and then the loud and long "hurrahs" are his well-deserved reward. His hands are burnt and his hair is singed, but what of that? he has saved two precious lives, and acted the part of a true hero. All hearts glow with admiration, and every one feels that he has been set a noble example of bravery and self-abnegation.

Every person in that crowd will remember the features of that one man till his dying day; whilst all the other thousands of faces, lighted up in the glare of the fire, will be entirely forgotten. Why will this be so? Simply because the interest was concentrated upon that one face, and it is interest and attention which indelibly fix facts and circumstances in the mind. Only enter heart and soul into any study, and you will never have to complain of a bad memory.

Macaulay possessed a most extraordinary memory, for his nephew, when writing the biography of his illustrious uncle, tells us that "at one period of his life he was known to say that if by some miracle of vandalism all the copies of Milton's 'Paradise Lost' and 'The Pilgrim's Progress' were destroyed off the face of the earth, he would undertake to reproduce them both from recollection."—*Life and Letters*, p. 52.

The study of mathematics is a great help in cultivating concentrated attention, for it necessitates an abstraction of the thoughts; hence it is made in all good schools a prominent and most important subject. The study of the classics also is another excellent discipline for the mind, and greatly improves and strengthens its powers; therefore, whether a

young man be going into a professional career or not, in passing through a curriculum embracing these subjects, he will receive mental training which will stand him in good stead whatever part he may have to play in the world. Doubtless, now that our intercourse with other nations is so constant and so intimate, every educated man must learn one or two Continental languages, and there is sometimes an outcry against the classics as a waste of time; this is, however, a great mistake, for twenty years' experience has proved to me that the best classic will become the best French scholar.

Frequently have I been asked to allow a lad to study English subjects and modern languages only. At the end of two or three years I have found that he has been far behind the boy who has gone in for mathematics and classics, as well as English, French, and German. Therefore, instead of gaining time by the neglect, he has missed the valuable discipline and the knowledge of the subjects also.

I cannot allow this opportunity to pass without mentioning that I entirely disbelieve in Phrenology: for a number of years it has struggled on, and has not yet been accepted as having any scientific *status;* and it never will be. Abercrombie years ago pointed out its inconsistencies, and the discoveries which I have before mentioned in reference to the cerebellum's being the chief seat of the nerves of motion, I think, quite settle the matter. For those who teach Phrenology place at the back and lower part of the head the animal faculties, and amongst them even philoprogenitiveness, or the love of offspring, which is one of the highest and most important of them all, and shows itself in the animal creation as a strong instinct, but in mankind as a holy principle leading parents to deny themselves for their children, and prompting them to great exertions and noble deeds that they may confer upon them both wealth and distinction.

Can anything be conceived more touchingly beautiful than a mother's love? Will she not suffer anything for her boy? Will she not sacrifice her property, her health, and sometimes even her life, for his sake? and even should he not return that devotion with like affection, she is still patient, still prayerful, still hopeful. But when her gentle teaching is appreciated, and he, prompted by her love, encouraged by her smiles, and aided by her prayers, rises step after step in the achievement of noble deeds which gain for him the esteem and admiration of his fellow-men, how her breast glows with delight! and entering into her closet she falls down before her Heavenly Father, and thanks Him from the bottom of her heart that He has given her such a son.

I have heard it said that most if not all of our eminent men have attributed their success in life to the early training they received from their mothers. It is then the mothers of England who are the real cause of all its greatness and of all its piety. And can we not be proud of the noble example of our Queen, in whom all the domestic virtues have so shone forth that she stands alone in this respect above all those who have ever sat upon England's throne?

It was by an inexplicable providence that her noble husband was called away in the zenith of his usefulness, but his highly cultivated mind and sterling piety have left behind them impressions which will never be effaced, and all the world will ever remember him as "Albert the Good." It will be the brightest page in our history when the reign of our illustrious Queen is recorded, with all the good that has been done by innumerable philanthropic institutions encouraged and fostered by her patronage and support; with all the advancement in education and in civil and religious liberty; with all the marvellous progress in science, which has enlarged our ideas of God's creation, and has so improved *our public* and domestic arrangements that increased health

and happiness have been the result;—when, I say, all these things are written down, and her nobleness, her greatness, and her piety have been indelibly recorded, the summing-up of all will be that she was a devoted wife and a truly loving mother!

I may be pardoned for just mentioning my own mother, who died when I was only five years old, but whom I remember most distinctly, and can recall her gentle, pious teaching. Also I recollect standing by her bedside with all the family, who had been gathered together to hear her farewell words, which were, "Love one another." How sacred is the memory of a godly mother!

After this short digression let me sum up the leading sentiments of the chapter.

With a body noble in origin and a soul Divine in nature and essence, Man's mission here is to glorify his Creator; and his future reward will be the eternal enjoyment of intercourse with his God.

CHAPTER XII.

"God ended his Work which he had made."

"Wherefore the Lord blessed the Sabbath day and hallowed it."

HITHERTO I have sought to lay before my readers the harmony existing between Science and our much-prized Bible; now I must enter upon the still more delightful part of my task, and endeavour to show that this holy book not only reveals to us God's wondrous power, but also His infinite love.

Moses had seen six great epochs of the world's history, and then it was doubtless communicated to him that such special acts of creation would henceforth cease. The laws, however, of reproduction, variation, natural selection, survival of the fittest, and ten thousand others of like importance, would all harmonise and continue in operation, until another Divine edict should go forth—that

"Time should be no longer."

It was part of God's plan that man should till the soil, and that he should obtain the necessities and enjoyments of life by labour and toil. The ground was not to bring forth fruits and flowers spontaneously, but he was to avail himself of those various laws which insure the productiveness of the Earth. But there was a blessing attached to this labour, for he was to derive happiness, not only from the constant reward attendant upon his exertions, but also from the healthy tone such industry would impart both to his body *and mind.*

Though it was thus appointed, that by the sweat of his brow he should obtain his bread, a kind and loving God ordained for him also a periodical rest, when he should desist from all his labour.

God knew that the constitution of man's body and mind required this periodical rest, and knew also that if he were taken up entirely with the cares and pleasures of the world he would quite forget that there was another, higher, happier, and more noble existence in store for him. God also knew that it would not be sufficient simply to suggest such a rest, but that it was necessary to constitute it a law, with no option left to man as to its observance; and, therefore, He attached a blessing to such observance of the day, and unhappiness to its violation.

Well do I remember, some years ago, being much struck on hearing that one of the largest and wealthiest merchants in London had so far lost his reason that he fancied himself a pauper, and in order to pacify him, his family were obliged to pretend to give him parish relief. For years this man, who is said to have died worth millions, was paid a small sum a week by a feigned relieving officer; and now comes the sad moral of this sad story. Instead of resting his mind and body, he had been wont to go down to the City every Sunday to his counting-house and examine his ledgers and cash-books, stating as his reason that he could do so better when the place was quiet. Alas! alas! for him, all the accumulation of wealth which those ledgers told him of was utterly useless as far as he was concerned, for his very sin brought with it its punishment. The mental disease from which he suffered was entirely caused by his not taking the rest appointed by a wise and beneficent Creator. Had he stayed at home with his family and enjoyed the soothing influences of religious occupation, holding communion with his God, and thinking of his heavenly rather than his worldly estate,

he would in all probability have lived happily and well to a good old age.

Another story, of the opposite kind, is equally remarkable. A young man set up in business in a country town, and strictly closed his premises on the Sabbath-day. After a year or two he was so successful that a prosperous career seemed in store for him. Soon, however, another man in the same line of business set up in opposition, and with large plate-glass windows and plenty of gas attracted the customers of his neighbour; also he had his doors wide open on the Sabbath-day, which rendered him popular with the ungodly. For a time the cloud hung over the Sabbath-keeper, and he was sorely tempted to imitate his opponent in order to regain his customers; but he was preserved from falling into the error. After a time it was found that the Sabbath-breaker was not conscientious, and though he pretended to sell his articles cheaply, there was often short weight and short measure. Gradually the tide turned again, and, finding the Sabbath-keeper to be far the better man of the two, even the godless returned to him, so that prosperity a second time set in, whilst the Sabbath-breaker lost both customers and credit, and before long became a bankrupt. His goods were put up for auction and his premises let, not to another stranger, but to the man who believed that God would eventually bless him if he kept His Sabbath and reverenced His sanctuary.

Instances of the above kind could be multiplied without number. I have known professional men break down entirely from working seven days a week, and I have known others live to a hale and hearty old age who have conscientiously locked up their briefs, their drawings, and their papers on the Saturday night, remembering that "*the Sabbath was made for man, and not man for the Sabbath.*"

I must now notice that the statement in the fourth *commandment,* that in six days God made the heavens and

the earth, and rested on the seventh day, is thought by many to be a conclusive argument in favour of the theory that actual days of twenty-four hours are meant.

This interpretation, Hugh Miller says, is reasoning from a mere assumption, as it takes for granted that the Sabbath-day during which God rested was a day of but twenty-four hours; and then in order to keep up the proportion between six working days and the seventh day of rest, these previous days must also have been days of twenty-four hours each.

It would square better with the ascertained facts, and be equally in accordance with Scripture, to reverse the process, and argue that, because God's working days were immensely protracted periods, His Sabbath must also be an immensely protracted period.

The reason attached to the law of the Sabbath seems to be simply a reason of proportion, and the word "period" might with great propriety be substituted for "day" in this commandment without altering one iota of its importance; in fact, to the scientific mind such rendering would add great force to the injunction.

Hugh Miller goes on to say that—

"Man, when in his unfallen state, bore the image of God, but it must have been a miniature image at best. The proportion of man's week to that of his Maker's may, for aught that appears, be mathematically just in its proportions, and yet be a miniature image too—the mere scale of a map on which inches represent geographical degrees.

"All those week-days and Sabbath-days of man which have come and gone since man first entered upon this scene of being, with all which shall yet come and go, until the resurrection of the dead terminates the work of Redemption, may be included, and probably are included, in the one Sabbath-day of God."

To confirm this latter statement he further says:—

"We have not, as has been shown, a shadow of evidence that He resumed His work of creation on the morrow: the geologist

finds no trace of post-Adamic creation; the theologian can tell us of none.

"That elevatory process through successive acts of creation which engaged Him during myriads of ages was of an ordinary week-day character; but when the term of His moral government began, the elevatory process proper to it assumed the Divine character of the Sabbath.

"This special view appears to lend peculiar emphasis to the reason embodied in the commandment, which might be thus paraphrased:—'Keep this day, not merely as a day of memorial related to a past fact, but also as a day of co-operation with God in the work of elevation, in relation both to a present fact and a future purpose.'

"God keeps His Sabbath, it says, in order that He may save; keep yours also, in order that ye may be saved. It serves besides to throw light on the prominence of the Sabbatical command in a digest of laws of which no part or tittle can pass away until the fulfilment of all things.

"During the present dynasty of probation and trial, that special work of both God and man on which the character of the future dynasty depends, is the Sabbath-day work of saving and being saved."

There is a fact which is quite overlooked by many, but which appears to me a remarkable and important one. In Moses' account of God's rest from the work of creation he does not say that the evening and the morning were the seventh day, manifestly indicating that it had commenced but not closed, which is strong evidence in favour of the above reasoning.

I have thus given almost in full the beautiful and lucid explanation of this deeply interesting subject by one of our most devout philosophers. He must have worked out the problem with great care and much prayerful thought, for he has succeeded beyond all question in putting the matter in such a clear light that his explanation honours the God he so much loved, and heightens our obligation *to keep* the Sabbath.

We must notice that this day of rest was not only blessed, but it was "hallowed." Worldly amusements, though quite proper and even necessary, are doubtless unlawful upon this holy day; not that I would agree with that sanctimonious observance of it which prevailed in Puritan times. Rather would I have it rendered a bright and cheerful day, when the mind, filled with love to God and man, is at perfect ease; and whether associating with friends in worship, or in enjoying the sweets of the domestic circle, cheerfulness should be the prevailing element.

I certainly should not consider it wrong to examine works of Nature or Art on the Sabbath-day; the first being the beautiful productions of our Heavenly Father, and the second those of gifted men, who by their talent manifest that a spark of Divinity is implanted within them. But I would not have public museums opened on the Sabbath-day, because such a plan would entail seven days' labour upon a number of necessary officials, who also require rest; and it would, I cannot but fear, in time lead to places of ordinary amusement being also opened.

It will be remembered with pleasure that it was one of the last acts of the late much-lamented Lord Beaconsfield to vote for Lord Shaftesbury's amendment against the opening of the museums on Sundays, which showed most clearly that he thought such a plan would be injurious to the people and displeasing to God.

That Lord Shaftesbury was the proposer of the amendment should surely be sufficient for the working men of England to feel that the best of motives prompted this opposition to Lord Dunraven's motion; for has not the venerable nobleman of fourscore years devoted a long life to their best interests? and has he not also helped to raise from the lowest depths of poverty and vice hundreds of thousands of ragged children, who would otherwise have grown up a curse to

themselves and their country? Men with such large and loving hearts may be safely trusted with measures like this.

The argument that it would take men from the public-house is extremely weak and fallacious; for those who crowd into stuffy tap-rooms to pour liquor down their throats are not such as would go to museums on the Sunday, even if they were opened.

There is another important matter connected with this subject, which is the lawfulness of seeking fresh air in the country lanes or fields on the Sabbath-day; and I should say that it was not only right, but even a duty, when it could be done without employing the labour of railway officials or others.

To get away from a crowded and smoky city, and to look upon green foliage and wild flowers, could not but produce a beneficial effect upon body and mind, especially if such enjoyments were sought before or after the public services in God's house. But I could not hold with the employment of cabs, omnibuses, tramways, and trains to carry people to the outskirts of London or any other large town, only to crowd the suburban public-houses and their tea-gardens and skittle-grounds. Many, perhaps, will disagree with the opinions I hold upon this point, but I would not have a vehicle of any kind used *for purposes of pleasure* on the Sabbath. For works of necessity and works of charity, doubtless both men and horses must sometimes be employed; but I scarcely think it desirable even to ride to a distant church or chapel when there are others within a walking distance. This was once most forcibly impressed upon my mind by a remark from the driver of an omnibus, who was telling me that he scarcely ever got a Sunday to himself, and added in a sad tone of voice, "I drive people to church, sir, and they leave me at the door, quite forgetting that I have also a soul. And I *think*," he added, "if I were able to drive them to heaven,

they would leave me with just as much unconcern outside its gates."

The thought has often struck me what an excellent example Jewish tradesmen and workmen set us in this respect, how uncomplainingly they give up two days every week in order that they may serve God according to their consciences; and is it not worthy of remark that they do not seem to suffer commercially on this account, but rather do they not generally prosper in business, and as a rule become wealthy men?

We may sum the whole matter up in this, that when God instituted the Sabbath it was intended by Him to be a special blessing to man; that its rest might restore a healthy tone to his body and mind; that its sacred duties might keep alive in him those religious feelings which constant contact with the world would destroy; that, being free from business occupations, he might draw near to Him in prayer and praise, and thus become better fitted to fight the battle of life, until at last, the victory being won, he would exchange this scene of trial and probation for a heavenly welcome and an eternal rest.

CHAPTER XIII.

Recapitulation.

HAVING thus brought to a close the arguments and facts in my endeavour to prove that all the events of creation were given by Moses in their right order, I think it would be as well here to recapitulate them, that you may recall the contents of each chapter, and decide upon the proofs of the Patriarch's inspiration. If I have succeeded in the task I set myself to do, then, without such inspiration, there would have been *hundreds of millions* of chances against his describing correctly these gradual yet marvellous operations in bringing about the present condition of our Earth.

In the sublime opening, announcing that "in the beginning God created the heavens and the earth," we notice there is a statement that there was a commencement of the Solar System, and that our Sun and planets had not existed from all eternity; but how long ago it was since this beginning took place, neither words nor figures can express. Year by year, as science advances, we are obliged to go back farther and farther and farther. At first mankind thought the starting-point was only a few thousands of years ago; then it was found they must be numbered by millions; now, not a few philosophers think that æons of ages will not satisfy the requirements of the problem; and therefore we must be content to know that, whenever that far-back period was, God planned the whole scheme of Creation, and then ordained that the present combinations and infinite variations *in the* arrangements of atoms should be brought about

by long, yet well-arranged processes, in the following order. We may also conclude that as there never was a time when God did not exist, and as activity is an essential part of His Being, that there also never was a time when worlds did not exist:—

I. Astronomical facts go to prove that other worlds were formed before our Solar System, and therefore Moses was quite right in placing the creation of the Heavens first.

II. Darkness existed throughout the fathomless abyss until the edict went forth, "Let there be light!" when the laws of gravitation, chemical affinity, &c., coming into operation, matter then existing in a highly attenuated condition became luminous nebulæ. On the condensation of these nebulæ, spherical bodies possessing intense heat were formed, lighting up the whole of space with ten thousand times ten thousand suns and stars.

III. Then, in the case of the Earth, after the nebulous condensation was completed, and there was but little accession of heat from the downpour of meteoric bodies, it gradually cooled, and the fiery mass in time was covered over by a thin rocky coating: this thickened sufficiently to confine the intense heat beneath the incrustation, and the hydrogen and oxygen which had united to form vaporous gas became condensed, and descending upon all sides of the Earth completely encased it with water, forming a universal ocean; as the Psalmist says, "O Lord my God, Thou art very great, . . . who laid the foundations of the Earth, that it should not be removed for ever. *Thou coveredst it with the deep as with a garment.*" The atmosphere also at this time separated the waters that were beneath the expanse from those that were above it.

IV. Ages upon ages rolled on, and the Laurentian, the Cambrian, and the Silurian rocks were gradually formed, for the most part probably under water; and then came a

mighty upheaval of the Earth's crust, and mountain-chains were raised up above the primæval waters, carrying with them to their summits animals which lived at the bottom of the seas, thereby affording us the means of accurately telling the period when those fearful convulsions took place; this rising of the Earth's crust above the waters formed separate oceans and seas, and caused dry land to appear. But not only did mountain-chains rise out of the water by forcible upheavals, but continents and islands were formed by the *gradual* subsidence of some parts and the elevation of others. Even the tiny polyps played an important part in these changes of the Earth's surface.

V. Hereupon from the ground there sprouted forth a low class of plants, such as lichens and fungi (Thallophytes), corresponding with the Algæ, which existed in the seas long before, and afterwards a higher class of Cryptogams (Acrogens) covered the Earth, composed of Club-mosses, Equisetaceæ, Tree-ferns, and numerous other flowerless plants, propagated by spores, not by seeds; therefore seeds are not mentioned, but the word "sproutage" is used.

VI. Then there was a further advance of vegetation, of a low class of Phænogams or flowering plants, such as Conifers, &c., having naked seeds, that is, not covered as in true fruits, and having a woody tissue of simple structure.

VII. Afterwards a higher class of Phænogams appeared, with nut-like seeds in fleshy envelopes, bearing a low order of fruit, perhaps allied to the edible Ginkgo of Japan.

During all this time it is thought that the Earth was surrounded with dense vapours, which, to a great extent, hid the direct rays of the Sun; and but one climate, a warm and moist one, pervaded the whole globe.

These Ferns and Conifers were buried up in vast quantities, to form our Coal Measures; but notwithstanding the *excessive* pressure, and the chemical changes consequent

thereupon, many vestiges have been wonderfully — yea, providentially—preserved, to tell the story of all their beauty and greatness, and to furnish us with a history of what the world was like in ages long gone by.

VIII. In time the globe still further cooled (it had been surrounded with much carbonic acid, which is a bad conductor of heat), and the vaporous clouds cleared away, and then the Sun and Moon were appointed for signs and for seasons.

I have before noticed that the Hebrew word עָשָׂה (*āsāh*) should not in this place have been translated "made," but "appointed," for it has hitherto conveyed to men's minds the idea that the Sun and Moon were not created until the fourth period, and therefore after the plants—an hypothesis quite contrary to Science, and even to common sense. The proof I have given that this period was the commencement of seasons, I think, makes the whole subject most clear and intelligible. Touchingly beautiful, also, is the expression, "*He made the stars also;*" as though it were said, "Do not think that the Sun and Moon, which warm and illuminate the Earth, are the only heavenly bodies made by the Great Creator."

Those bright, those glorious orbs of light were also His handiwork, and the Solar System, with all its magnificence, is but a tiny speck in His universe. Suns and worlds, in countless numbers and of endless beauty, fill yonder space and proclaim His glory, His majesty, and His power.

IX. Now that the Sun shone directly upon the Earth, a great change was manifested, and there is evidence in the Permian, Oolitic, Trias, and Lias periods, that such direct rays produced a considerable alteration in the appearance both of sea and land—the former brought forth an abundance of new species that sported in its waters; amongst which numerous species of beautiful Ammonites rose to the surface to bask in the Sun's rays, and descended again to their watery home, and with millions of Belemnites swam to and

fro; whilst the vegetation of the latter indicated the existence of sunshine.

X. The air also teemed with life, for winged fowl now for the first time appeared; and that we might learn how accurately Moses described the order of creation, they left behind them footprints too well defined to be mistaken.

XI. Now mark, that after the birds great *sea-monsters* appeared, and the Ichthyosaurus and Plesiosaurus reigned in the ocean. I must again call your attention to the words, "*And God created great whales;*" not evolved, but by a special exercise of His power brought at once these monsters into existence; and when their mission was done, whatever it might have been, they were all destroyed; leaving, however, many vestiges, that we might read in the stony records their greatness and their power.

XII. Then Moses tells us that God "*made the beast of the earth.*" I have in the eighth and ninth chapters described the monsters which roamed over the Earth in the Secondary, Tertiary, and Quaternary periods, which were indeed "great beasts," and such as would appal us now. The carnivorous Megalosaurus, the fierce lions, bears, and hyænas must have been fearful creatures indeed. But the Dinotherium, Megatherium, Mastodon and Mammoth, doubtless, looked more formidable than they really were, feeding as they did upon the prolific and spontaneous vegetation.

XIII. Though some of the bovine tribes lived contemporaneously with the Mammoth, &c., I have shown that other great beasts preceded them, and it was not until just before man that sheep made their appearance.

XIV. Agassiz says that the *principal* flowers and fruit-trees appeared only a short time before man, which corresponds with the Lord God planting a garden.

XV. And then comes the crowning and finishing stroke of the Almighty power and wisdom, when "*God created*

Man, in His own image, in the image of God created He him; male and female created He them."

I must emphatically call your attention to the word בָּרָא (*bāra*), "created," being mentioned for the third time in this wonderful narrative, and in this case thrice repeated to give special emphasis and power to the statement.

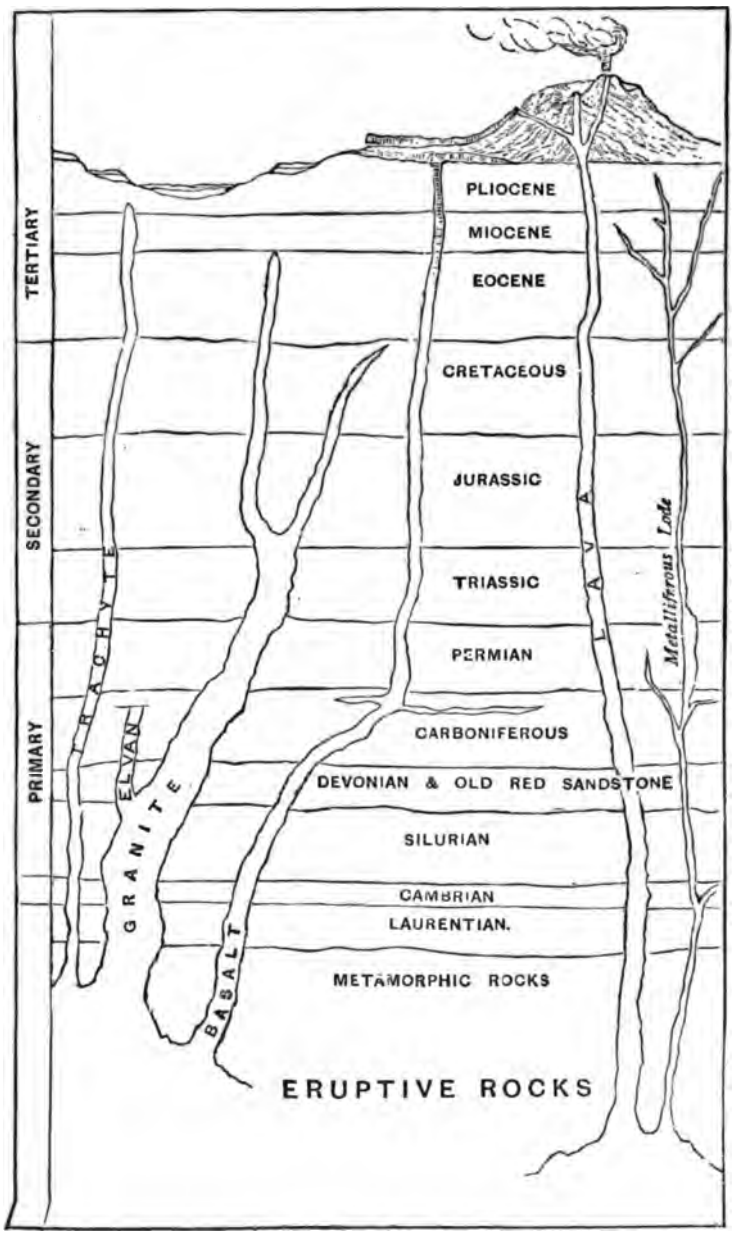
Man was not therefore evolved nor descended from any other animal, nor from a series of animals, but formed in the image of his Maker, of earthy elements, yet endowed with that spark of Divinity which raised him above all other species, and gave him the ability to glorify his God whilst here, and to enjoy communion and intercourse with Him hereafter.

Finally. "*God ended His work which He had made.*"

On the next page you will find a diagram of the British Sedimentary and Fossiliferous Strata, with condensed and extended Tables of all these strata, for which I am indebted to the kindness of Mr. Bristow, and if my readers will peruse them they will see at one glance a confirmation of all the different parts of my argument.

And now that I have brought this narrative to an end, how truly delighted I shall be if I have succeeded in removing some of the difficulties in which the subject has been shrouded! I cannot hope or expect that all the links in my chain of arguments will be considered perfect, and I am quite prepared to meet with opposition. Should, however, these chapters only succeed in calling forth more thought upon this important subject, then indeed a very great point will be gained, and I shall feel amply rewarded.

One thing is quite certain, that if we can start fairly with the first chapter of the Sacred Book, and feel assured that it contains remarkable evidences of a direct inspiration, then our confidence will be established, we shall feel that we can rely upon the whole as containing God's will to man, shall appreciate its teaching, and rejoice in its promises.



XIII.—*Diagram* of British Sedimentary and Fossiliferous Strata, by Mr. H. W. Bristow, F.R.S., &c.

	Subdivisions.	Foreign Equivalents.	Origin.	Commercial Products.
Post Pliocene.	Blown Sand. Raised Beaches. Alluvium. Brick Earth. River Gravel. Cave Deposits. Glacial Deposits.	Mud of the Nile. Loess of the Rhine.	Various.	Peat. Amber. Gold, Diamonds, and other Gems derived from the older deposits.
Pliocene.	Crags.	Sub-Apennine Strata.	Marine	Phosphatic Nodules.
Miocene.	Leaf Beds and Lignite.	Molasse. Faluns of Touraine.	and	Pipeclay.
Eocene.	Upper Eocene. Bagshot Beds. London Clay. Reading Beds, &c.	Calcaire Grossier. Nummulitic Limestones (European and Asiatic).	Freshwater. Estuarine and Marine.	Sand, Brown Coal, Pipeclay, Cement Stone, Bricks, and Pottery.
Upper Cretaceous.	White and Grey Chalk . Upper Greensand . . .	Maestricht Beds. Senonien Turonien.	Marine and Freshwater (Wealden).	Flints from Up. Chalk. Phosphate of Lime. Iron Pyrites. Sandy Ironstones. Building Stone.
Lower Cretaceous.	Gault . . . . . Lower Greensand . . Wealden Beds, &c. .	Albien. Aptien. Neocomian.		
Upper Oolitic. Middle Oolitic.	Purbeck. . . . Portland and Kimmeridge. Coral Rag & Oxford Clay.	Jura Formation.	Estuarine and Marine.	Coal, Jet, Iron Ores, Roofing Slates, Building Stones, and Flags. Alum Shales. Hydraulic Limestones.
Lower Oolitic.	Cornbrash. Forest Marble and Great Oolite. Stonesfield Slate. Inferior Oolite. Lias.		Marine.	
Keuper. Bunter.	Rhætic. New Red Marl, Sandstone, and Conglomerate. Sandstone & Pebble Beds	Muschelkalk absent in British Isles.	Inland Seas. Salt Lakes.	Gypsum. Rock Salt. Building Stones.
Magnesian Limestone. Lower Permian.	Red Marls and Magnesian Limestone. Red Marl, Sandstone, and Conglomerate.	Zechstein. Kupferschiefer. Rothliegende.	Marine.	Building Stones.
Carboniferous.	Coal Measures. Millstone Grit. Yoredale Rocks. Mountain Limestone.	Carboniferien.	Terrestrial and Marine.	Coal, Anthracite. Iron and Lead Ores. Bldng. Stone, Marble. Oil Springs.
Devonian and Old Red Sandstone	Devonian Slates and Limestones. Old Red Sandstone, &c.	Eifel Limestone.	Marine and Freshwater.	Ornamental Marbles. Serpentine & Slates. Tin, Copper, Lead, Silver Ores, &c.
Upper Silurian.	Ludlow. Wenlock. Upper Llandovery.		Marine.	Roofing Slates. Building Stones. Gold & other Metals.
Lower Silurian.	Lower Llandovery. Bala and Caradoc. Llandeilo. Lingula Flags	Primordial Zone.		
Cambrian.	Harlech Grits. Llanberis Slates.	Huronian of America.	Marine.	Roofing Slates. Gold & other Metals.
Laurentian.	Gneiss of the Outer Hebrides, and N.W. Coast of Scotland.	Labradorite Series in Canada.	Marine.	Serpentine Graphite.

Metamorphic Rocks (*of all ages*):—

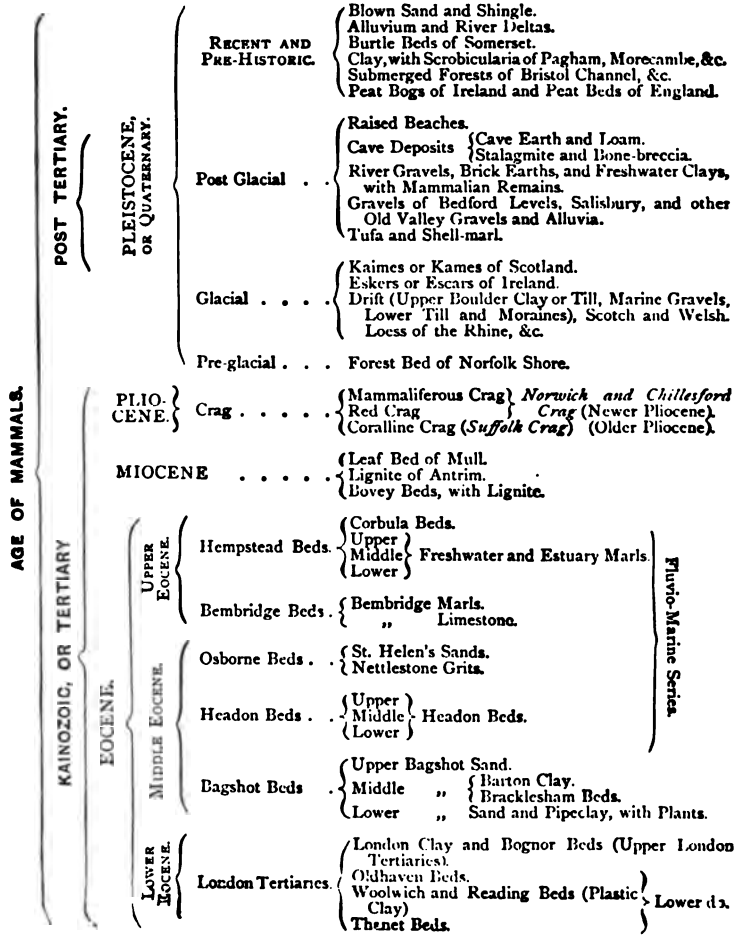
Gneiss, Mica-schist, Quartzite, Talcose-schist, &c. (Serpentine probably ?)

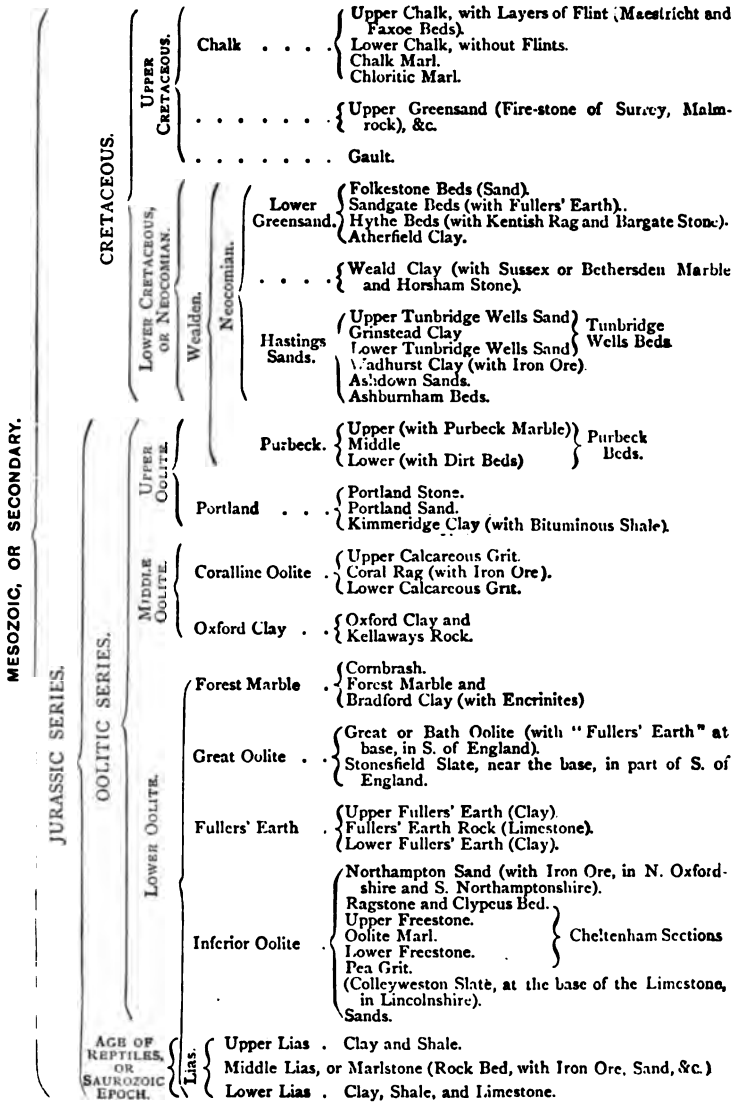
Intrusive Rocks (*of all ages*):—

Lavas, Basalt, Trachyte, Pitchstone, &c.

Granite, Syenite, Greenstone, Felstone, Porphyrites, Melaphyres, Mica-Trapa, &c. &c.

EXTENSION OF THE PREVIOUS TABLE.




MESOZOIC, OR SECONDARY.
JURASSIC SERIES.
CRETACEOUS.
Upper Cretaceous.
Chalk . . . .
Upper Chalk, with Layers of Flint (Maestricht and Faxoe Beds).
Lower Chalk, without Flints.
Chalk Marl.
Chloritic Marl.
. . . . . .
Upper Greensand (Fire-stone of Surrey, Malm-rock), &c.
. . . . . .
Gault.
Lower Cretaceous, or Neocomian.
Wealden.
Neocomian.
Lower Greensand.
Folkestone Beds (Sand).
Sandgate Beds (with Fullers' Earth).
Hythe Beds (with Kentish Rag and Bargate Stone).
Atherfield Clay.
. . . .
Weald Clay (with Sussex or Bethersden Marble and Horsham Stone).
Hastings Sands.
Upper Tunbridge Wells Sand
Grinstead Clay
Lower Tunbridge Wells Sand
Tunbridge Wells Beds.
Tadhurst Clay (with Iron Ore).
Ashdown Sands.
Ashburnham Beds.
OOLITIC SERIES.
Upper Oolite.
Purbeck.
Upper (with Purbeck Marble)
Middle
Lower (with Dirt Beds)
Purbeck Beds.
Portland . . .
Portland Stone.
Portland Sand.
Kimmeridge Clay (with Bituminous Shale).
Middle Oolite.
Coralline Oolite .
Upper Calcareous Grit.
Coral Rag (with Iron Ore).
Lower Calcareous Grit.
Oxford Clay . .
Oxford Clay and Kellaways Rock.
Lower Oolite.
Forest Marble .
Cornbrash.
Forest Marble and
Bradford Clay (with Encrinites)
Great Oolite . .
Great or Bath Oolite (with "Fullers' Earth" at base, in S. of England).
Stonesfield Slate, near the base, in part of S. of England.
Fullers' Earth .
Upper Fullers' Earth (Clay).
Fullers' Earth Rock (Limestone).
Lower Fullers' Earth (Clay).
Inferior Oolite .
Northampton Sand (with Iron Ore, in N. Oxfordshire and S. Northamptonshire).
Ragstone and Clypeus Bed.
Upper Freestone.
Oolite Marl.
Lower Freestone.
Pea Grit.
Cheltenham Sections
(Colleyweston Slate, at the base of the Limestone, in Lincolnshire).
Sands.
AGE OF REPTILES, OR SAUROZOIC EPOCH.
Lias.
Upper Lias . Clay and Shale.
Middle Lias, or Marlstone (Rock Bed, with Iron Ore, Sand, &c.)
Lower Lias . Clay, Shale, and Limestone.

MESOZOIC, OR SECONDARY—*continued.*	OOLITIC SERIES	TRIAS, OR NEW RED SANDSTONE.	UPPER TRIAS.	Rhætic, or Penarth Beds.	"White Lias," Avicula contorta Beds. with Koessen Beds. Bone Beds of Aust, &c. *St. Cassian and Hallstadt Beds.*
				Keuper	Red variegated Marl and Upper Keuper Sandstone (with Gypsum and Rock Salt). Lower Keuper Sandstone and Marl (Waterstones). Dolomitic Conglomerate (of Keuper Age, Somerset, Gloucester, and S. Wales).
			MIDDLE TRIAS.	. . . . .	*Muschelkalk, absent in Britain.*
			LOWER TRIAS.	Bunter	Upper Red and Mottled Sandstone. Pebble Beds, Calcareous Conglomerate, and Breccia. Lower Red and Mottled Sandstone.
PALÆOZOIC, OR PRIMARY.	UPPER PALÆOZOIC. AGE OF FISHES, OR ICHTHYOZOIC EPOCH.		PERMIAN.		GERMANY.
				Upper, or Magnesian Limestone Series.	Upper Red Marl and Sandstone Upper Magnesian Limestone Lower Red Marl and Sandstone Lower Magnesian Limestone } Zechstein.
				Lower, or Rothliegende.	Red Marl, Sandstone, Breccia, Rüthe-liegende, and Conglomerate.
		CARBONIFEROUS SERIES. AGE OF PLANTS, OR PHYTOZOIC EPOCH.			ENGLAND. / SCOTLAND.
				Coal Measures .	Upper Coal Measures Middle Coal Measures Pennant Grit Lower Coal Measures Gannister Beds } Upper Coal Measures.
				. . . . .	Millstone Grit or Farewell Rock } Moor Rock.
				Carboniferous, or Mountain Limestone.	Upper Limestone Shale (Yoredale Rocks) } Upper Limestones. Edge Coals Series. Carboniferous Limestone } Lower Limestones. Lower Limestone Shale } Sandstones, Shales, and Burdie House Limestone.
		OLD RED SANDSTONE AND DEVONIAN.		Old Red Sandstone, or Devonian Beds.	Upper Devonian or Barnstaple and Marwood Beds, with Petherwin Limestone, in N.E. Cornwall. Middle Devonian or Ilfracombe Beds, with Fossiliferous Limestones and Cornstones. Lower Devonian, or Lynton Beds.

				Wales and Central England.	Lake District.
Palæozoic, or Primary—*continued.*	Lower Palæozoic. Age of Crustaceans and Molluscs, or Malacozoic Epoch.	Silurian.	Upper Silurian.	. . . . . Tilestones (Passage Beds)	Kirkby Moor Flags.
				Ludlow Beds . . Upper Ludlow Beds (with Bone Bed)	
				Aymestry Limestone	Bannisdale Beds.
				Lower Ludlow Beds	
				Wenlock Beds . Wenlock Limestone	
				Wenlock Shale, Sandstone, and Flags	
				Woolhope Limestone and Shale	Coniston Grits and Flags.
				Denbighshire Grits, Shales, Slates, and Flags	Stockdale Slates.
				. . . . . Tarannon Shale (Pale Slates).	
				Llandovery Beds . Upper Llandovery Rocks. (May Hill Sandstone). (Pentamerus Beds).	
				Lower Llandovery Rocks.	
			Lower Silurian.	Caradoc, or Bala Beds. Caradoc and Bala Beds. (Sandstones often shelly, with Bala Limestone, Shale, and Slate)	Coniston Limestone, Bala (Limestone and Shale) Skiddaw Slates.
				Llandeilo . . . Llandeilo Flags and Limestone, &c. Tremadoc Slates.	
				Lingula Beds . . Lingula Flags. (Primordial Zone of Barrande).	
	Eozoic.	Cambrian.		Cambrian . . . Harlech Grits, &c. Purple Slates and Grits (St. David's). Llanberis Grits and Slates. Longmynd Rocks. Red Sandstone and Conglomerate (Scotland).	
		Laurentian		Fundamental Gneiss of the Outer Hebrides and of the N.W. coast of Scotland, &c., containing the oldest known fossil, *Eozoon Canadense*.	

ADDENDA CHAPTERS

ON

ASSYRIAN ANTIQUITIES,

THE SIGNS OF THE ZODIAC,

THE SCHEME OF REDEMPTION

AND THE

EFFICACY OF PRAYER.

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ADDENDA CHAPTERS.

CHAPTER I.

"Make thee an Ark of Gopher Wood."

Though the immediate object of this work is to show the harmony of the Bible with Science, I wish to say something about the marvellous confirmation which the historical portions of the Scriptures have received from the exhumation of the ruins of the long buried-up cities of Assyria.

Century after century sceptics and infidels have brought forward allegations against the Scriptural narratives, and good men have not always been able to find suitable answers to their specious objections, but were often obliged to say, "Though I may not be able to answer you satisfactorily, I still believe in the truth of the Bible, and feel sure that the time will come when its stories will no longer be considered 'myths.'" That time has now arrived, and none but those perfectly ignorant of the invaluable treasures in our British Museum will attempt to call in question the correctness of the events related in the Old Testament. Prominent amongst these relics is the "Deluge Tablet," which so marvellously confirms the story of the Noachian flood, and serves to strengthen our faith in all the Biblical narratives.

Before I give the translation of this tablet, I think I had better correct a wrong impression in reference to the extent of the deluge, which was confined to a small portion of Western Asia. The expression "the earth," or "all the earth,"

which occurs in Gen. vi. and vii., and has so often been thought to mean the entire globe, is explained by Marcel de Serres, in a learned book entitled "La Cosmogonie de Moïse," as being an inaccurate translation. He has proved that the Hebrew word הָאָרֶץ (*hāārĕts*), translated "the earth," is often used in the sense of *region* or *country*, and that Moses intended it to express only that part of the globe which was then peopled, and not its entire surface.

This is a very important point, for the water could not have covered the whole globe and all its mountains without a very large quantity being created specially for the purpose; for if all the water existing in the oceans, seas, rivers, and atmosphere, was deposited upon the globe, and equally divided over its surface, such a universal sea would only be about two-and-a-half miles in depth. And *thirty* times as much would have been required to have formed a casing of water that would have covered over all the mountains of the world; and then a most stupendous miracle would have been necessary to get rid of this enormous extra quantity of water, amounting to more than a thousand millions of *cubic miles*.

Moses, in his account, evidently did not wish us to suppose anything of this kind, for he says the waters prevailed fifteen cubits upwards. By the word "upwards" he implied that he did not know the exact amount of the waters, but, at any rate, they had risen more than twenty-six feet. So small a number of feet would not have been mentioned if 29,000 had been intended, which would have been necessary to cover Mount Everest. There can, I think, be no doubt but that Moses obtained his information from some tablets written by Noah, who only spoke of what he saw, and his range of vision was limited by the horizon. If the whole globe had been so encased with water, science would have discovered a confirmation of it, whereas there is everything in the infallible Book of Nature to contradict such a supposition.

In the following translation of the tablet (pages 402—409) you will notice that an earthquake is mentioned, and if you will refer back to the account of the earthquake of Lisbon* you will see that one effect of the convulsion was to raise the bed of the ocean, and thereby cause its waters to pour over the city. Such an earthquake is evidently intended in the Biblical account, when it says, "In the same day were all the fountains of the great deep broken up." Science also tells us of a catastrophe occurring about that time by the upheaval of a part of the chain of mountains which is a prolongation of the Caucasus. The volcanic cone of Mount Ararat, 17,323 feet high, being one of the peaks thus upheaved, threw out of its crater volcanic matter accompanied with volumes of steam, which, becoming condensed, descended in torrents of rain, and with the inundation of the sea drowned the whole plain.

Of upheavals of this kind I have given you a full account in another chapter,† and have also told you of a volcano in Mexico, in 1759, rising up from level ground in one night, and remaining to the present day.

There is another wrong impression—that the ark rested upon the top of Mount Ararat. The Bible does not say so, but that it rested upon the mountains of Ararat. Now the ark could not have rested upon several *mountains*, but it might float on to a portion of this chain of mountains, and be left there some feet above the ground when the waters subsided. In Mr. George Smith's translation of the "Deluge Tablet," we find it stated that "the mountain of Nizir *stopped* the ship; and to pass over it, it was not able."

Hence all the three sources of information—the Bible, Science, and this ancient tablet—coincide in reference to this catastrophe, and by their marvellous agreement most undoubtedly establish the truthfulness of each other.

* Page 135. † Page 97.

The discovery of this valuable relic came about in this way. Mr. Smith was looking over some tablets at the British Museum, and noticed on one a statement that the "ship" had rested on the mountain of Nizir, followed by an account of Noah's sending forth a dove; this convinced him that he had discovered a portion at least of the Chaldean account of the Noachian deluge. He sought for more fragments, and at last discovered portions of three copies, which he set to work to translate, and afterwards read these translations before a meeting of the Biblical Archæological Society, at which Mr. Gladstone was present. The next day the *Daily Telegraph* published the translation in full, and Mr. E. Arnold, in the name of the proprietors of that paper, most generously offered one thousand guineas to send out Mr. Smith to those ancient ruins, to institute further researches.

He started off full of spirits, with the best wishes of all and the approbation of the Government, who not only consented to his leaving his post at the British Museum, but also undertook to continue his salary while absent.

Now I have something very interesting to tell. When Mr. Smith was reading his translation, there were several breaks in the continuity of the story, in consequence of the tablets being much chipped and some portions being missing. He had not been absent long when he wrote home to the editor of the *Telegraph* to say that he had found some of the missing pieces belonging to the first column of the tablet, containing the command to build the ark, which nearly filled up the most considerable blank in the story. This seemed little short of miraculous, for many years had elapsed since the tablets had been brought to England, and up to the time of Mr. Smith's translation no one thought them of much value; he also had never been on the spot before, and therefore had not the least idea where to look for them *amidst* the millions and millions of fragments scattered over

a very large area. Nevertheless, the piece was found—accidentally, shall I say?—no, I will not: it must have been providentially, to encourage and cheer him in his investigations; and I think a still higher good resulted, for it greatly increased the interest in this remarkable tablet, and thereby God's Word received a further confirmation.

It will also ever be remembered with pleasure that the proprietors of so eminent and popular a newspaper should take such a generous interest in this subject.

It must strike every one that, as this Babylonian legend can be proved to be some 4,000 years old, and therefore written soon after Noah's time, combined with the evidence that it was the account given by him to Nimrod, the Biblical story has received a remarkable confirmation.

Whilst, however, there are so many things in reference to this interesting matter of a pleasing nature, there is also a very sad one; for on Mr. Smith's going out a third time he fell a victim to over-fatigue, caused by his untiring zeal in Assyrian research. His death will ever be regretted by all who knew his great worth. One of his works, "Babylonia," in which he had given the translation of this tablet, was only in manuscript, but in so complete a state that the Rev. A. H. Sayce, Deputy-Professor of Comparative Philology at Oxford University, found no difficulty in editing it. From this translation I have selected a series of lines for which I could find parallel passages in our Biblical story; and as great advance has been made in reading the Assyrian language since Mr. Smith's lamented death, I have given some improved renderings of the lines kindly furnished me by Mr. T. G. Pinches, of the Department of Oriental Antiquities in the British Museum; and some others I have taken from Professor Sayce's revision of Mr. Smith's valuable work, "The Chaldean Account of Genesis." In the third left-hand column the reader will find the name of each translator.

Column.	Line.	Translators.	Translations of the Tablet.
1	8	Sayce.	Xisithrus to him also speaks, even to Izdhubar.
1	9	Sayce.	Let me reveal to thee (Izdhubar) the story of my preservation.
1	10	Sayce.	And the judgment of the Gods let me relate to thee.
1	20	Smith.	Suruppakite, son of Ubara-Tutu.
1	22	Pinches.	The seed also of life is become estranged.
1	21	Pinches.	Destroy the house, build a ship.
1	25	Smith.	. . . . cubits shall be the measure of its length.
1	26	Smith.	. . . . cubits the amount of its breadth, and its height.
2	5	Smith.	I placed its roof, I enclosed it.
2	10	Smith.	Three measures of bitumen I poured over the outside.
2	11	Smith.	Three measures of bitumen I poured over the inside.
2	12	Sayce.	Three *sari* of men carrying baskets, who carried on their heads food.
2	13	Sayce.	I added a *saros* of food, which the people should eat.
2	17	Pinches.	. . . . sweet wine, oil, and wine

PARALLEL PASSAGES FROM THE BIBLICAL VERSION.

(*Xisithrus, or Noah, in the Tablet account is relating the story of the Deluge to Izdhubar, who, in Mr. Smith's opinion, is Nimrod. In the following Biblical account Moses relates the occurrence historically.*)

And God said unto Noah	Gen. vi. 13.
The end of all flesh is come before me; for the Earth is filled with violence	Gen. vi. 13.
Make thee an ark of gopher wood	Gen. vi. 14.
The length of the ark shall be three hundred cubits .	Gen. vi. 15.
The breadth of it fifty cubits, and the height of it thirty cubits	Gen. vi. 15.
Rooms shalt thou make in the ark	Gen. vi. 14.
And shalt pitch it within and without with pitch .	Gen. vi. 14.
And take thou unto thee of all food that is eaten, and thou shalt gather it to thee; and it shall be for food for thee, and for them . . .	Gen. vi. 21.

Column.	Line.	Translators.	Translations of the Tablet.
2	18	Smith.	(I collected) like the waters of a river.
2	19	Pinches.	The water of the Earth also
2	20	Pinches.	(in) cisterns my hands placed.
2	28	Pinches.	I caused to go up into the ship all my family and my female servants.
2	29	Smith.	The beasts of the field, the animals of the field, all of them I caused to go up.
2	30	Smith.	A flood Shamas made, and he spoke, saying, "In the night I will cause it to rain from heaven heavily."
2	32	Smith.	Enter into the midst of the ship and shut thy door.
2	40	Pinches.	The dawn in brightness arose.*
2	41	Sayce.	Arose from the horizon of heaven a black cloud.
2	42	Sayce.	Rimmon in the midst thundered.
2	50	Smith.	The bright Earth to a waste was turned.
3	1	Smith.	The surface of the Earth like . . . . it swept.

* Literally: "Mû-sêri arose in brightness." This Mû-sêri (which is found also on other tablets) seems to be a personification of the dawn. The name means, *literally*, "Water of dawn" (Pinches).

PARALLEL PASSAGES FROM THE BIBLICAL VERSION.

And take thou unto thee of all food that is eaten, and thou shalt gather it to thee; and it shall be for food for thee, and for them . . . Gen. vi. 21.

And thou shalt come into the ark, thou, and thy sons, and thy wife, and thy sons' wives with thee Gen. vi. 18.

And of every living thing of all flesh . . . Gen. vi. 19.

Of fowls after their kind, and of cattle after their kind, of every creeping thing of the Earth after his kind . . . . . Gen. vi. 20.

And, behold, I, even I, do bring a flood of waters upon the Earth, to destroy all flesh . . . Gen. vi. 17.

And they that went in, went in male and female of all flesh, as God had commanded him: and the Lord shut him in . . . . . Gen. vii. 16.

The same day were all the fountains of the great deep broken up, and the windows of heaven were opened, and the rain was upon the Earth . . Gen. vii. 11, 12.

And the waters prevailed, and were increased greatly upon the Earth . . . . . Gen. vii. 18.

Column.	Line.	Translators.	Translations of the Tablet.
3	3	Sayce.	The raging (deluge) over the people reached to heaven.
3	2	Smith.	(It destroyed all) life from the face of the Earth.
3	25	Smith.	And the whole of mankind was turned to corruption.
3	26	Smith.	Like reeds the corpses floated.
3	21	Smith.	. . . . from heaven the rain and all the deluge
3	22	Smith.	Which had destroyed like an earthquake
3	23	Smith.	Quieted.
3	23	Sayce.	The sea began to dry.
3	23	Pinches.	And the evil wind and deluge ended.
3	32	Sayce.	In the country of Nizir rested the ship.
3	33	Smith.	The mountain of Nizir stopped the ship; and to pass over it, it was not able.
3	27	Smith.	I opened my window, and light broke over my face.
3	38	Sayce.	I sent forth a dove, and it left, the dove went, it returned, and
3	39	Sayce.	A resting place it did not find, and it came back.

PARALLEL PASSAGES FROM THE BIBLICAL VERSION.

And all the high hills, that were under the whole heaven, were covered . . . . . Gen. vii. 19.

And all flesh died that moved upon the Earth, both of fowl, and of cattle, and of beast, and of every creeping thing that creepeth upon the Earth, and every man . . . . . Gen. vii. 21.

And God made a wind to pass over the Earth, and the waters asswaged . . . . . Gen. viii. 1.

The fountains also of the deep and the windows of heaven were stopped, and the rain from heaven was restrained . . . . . Gen. viii. 2.

And the ark rested in the seventh month, on the seventeenth day of the month, upon the mountains of Ararat . . . . . Gen. viii. 4.

And it came to pass at the end of forty days, that Noah opened the window of the ark which he had made . . . . . Gen. viii. 6.

He sent forth a dove from him, to see if the waters were abated from off the face of the ground . Gen. viii. 8

But the dove found no rest for the sole of her foot, and she returned unto him into the ark . . Gen. viii. 9

Column.	Line.	Translators.	Translations of the Tablet.
3	42	Smith.	I sent forth a raven, and it left.
3	43	Smith.	The raven went, and the corpses which were on the water it saw, and
3	44	Smith.	It did eat, it swam, it wandered away, it did not return.
3	45	Smith.	I sent forth the animals to the four winds.
3	46	Smith.	I built an altar on the peak of the mountain.
3	49	Smith.	The Gods collected at the burning, the Gods collected at the good burning.
3	52	Sayce.	. . . lifted up the mighty arches (*i.e.*, the rainbow) which Anu had created in his glory.
3	26	Pinches.	He made a bond, he stayed among us, and was gracious to us.

PARALLEL PASSAGES FROM THE BIBLICAL VERSION.

And he sent forth a raven, which went forth to and fro, until the waters were dried up from off the Earth	Gen. viii. 7.
And Noah went forth, and his sons, and his wife, and his sons' wives with him: every beast, every creeping thing * * * went forth out of the ark	Gen. viii. 18, 19.
And Noah builded an altar unto the Lord, and offered burnt offerings upon the altar. . .	Gen. viii. 20.
And the Lord smelled a sweet savour . . .	Gen. viii. 21.
I do set my bow in the cloud, and it shall be for a token of a covenant between me and the Earth .	Gen. ix. 13.
And God spake unto Noah, and to his sons with him, saying: And I, behold, I establish my covenant with you, and with your seed after you . .	Gen. ix. 8, 9.
And God blessed Noah and his sons, and said unto them, Be fruitful, and multiply, and replenish the Earth	Gen. ix. 1.

To afford you some idea of the difficulties which Mr. Smith and other translators must have encountered, I give the following fac-simile of one of these tablets (Fig. 88), which has been most kindly furnished me by Messrs. Sampson Low and Marston, and appears in their excellent edition of Professor Sayce's "Chaldean Account of Genesis," published in 1880, in which are also translations of other Assyrian tablets, con-

Fig. 88.—Reverse of inscribed terra-cotta Tablet containing the Account of the Deluge, showing the various fragments of which it was composed at the time of Mr. Smith's translation.

taining descriptions of the Creation, the Deluge, the Tower of Babel, the Destruction of Sodom, and the Times of the Patriarchs. This work, together with "Babylonia" and "Ancient History from the Monuments of Assyria," also written by Mr. Smith, and published by the Society for Promoting Christian Knowledge, should be in the library of every one interested in these subjects. It would be impossible to speak too highly of these works, for they

XIV.—Sennacherib on his Throne before Lachish.

are the outcome of many years' laborious and patient study by men of great genius and deep learning.

Amongst the treasures in the British Museum there is a slab representing Sennacherib sitting on a magnificent throne before Lachish, of which Plate XIV., from Mr. Smith's "Assyria," is a copy; and Mr. Pinches has given me the following translation of the inscription above the king:—

"Sennacherib, king of multitudes, king of the land of Assur, sits on his throne, while the spoil of Lakis passes before him."

On this occasion he dictated terms to Hezekiah, the humbled King of Judah, who sent his messenger to make submission, and to give tribute, including 30 talents of gold, 800 talents of silver, precious stones of various sorts, couches and thrones of ivory, skins and tusks of elephants, and male and female musicians. According to this record, Sennacherib returned to Nineveh in triumph, bearing with him this tribute and spoil.

On a black marble obelisk in the Museum there is an account of the tribute paid by Omri to Shalmaneser; and Mr. Rassam thinks that the kneeling figure before the king is Jehu, or his ambassador. Upon terra-cotta cylinders we find particulars of the wars between Sennacherib and Hezekiah. Upon an unbaked clay tablet there is an official record of the taking of Babylon by Cyrus; and, in fact, nearly all the stories of the Old Testament characters are more or less confirmed in our wonderful and invaluable collection.

Perhaps of all the relics the most interesting are the bronze plates found by Mr. Rassam in Assyria, which once covered the gates of the royal palace at Imgur-Bêl, a town some nine miles north-east of Nimroud, and a suburban residence of the kings of the Middle Assyrian Empire. These gates were about 22 feet high and 12 feet wide, and the plates,

about 18 inches in width, extended across them as shown in Fig. 89, drawn by Mr. Pinches, and which is more perfect than the sketch I drew for the *Graphic* newspaper of Nov. 23,

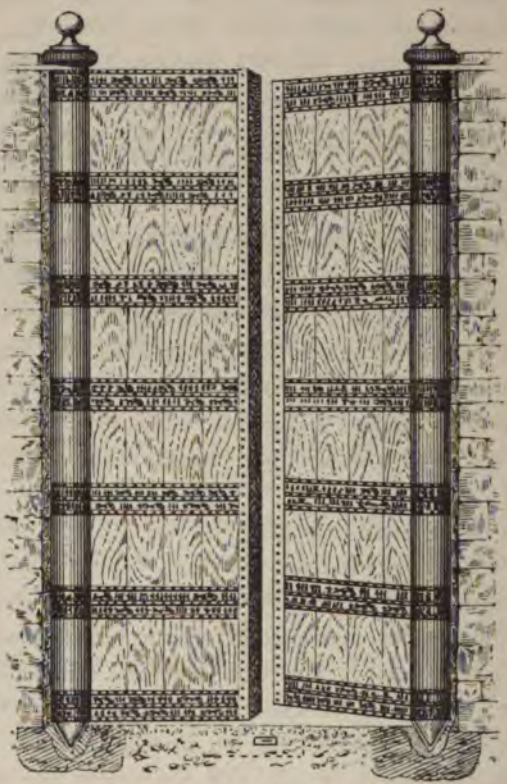

Fig. 89.—Gates of a Palace in a Suburban Town of Nineveh.

1878; these plates indicate the high state of art to which bronze-work had reached three thousand years ago. The figures upon them are bas-reliefs, and some of them relate to the great campaign of Shalmaneser II. against the Syrian confederation, which was composed of Ahab (King of Israel), Benhadad (King of Syria), and Urkhilini (King of Hamath).

This subject is so deeply interesting to me that I feel strongly tempted to exceed the limits of my space to describe many more of the slabs and tablets; but I hope some day to publish an account of them as an addendum to this work.

There is one, however, that I cannot leave out; this is a slab on which the king is represented engaged in some religious ceremony, with a figure of the national god Assur above him, and a floral device symbolical of Asheerah or Astarte,

Fig. 90.—Floral Device symbolical of Astarte.

the wife of Baal, in front of him (Fig. 90).* Now this word *Asheerah* has been translated "grove" in our Bible, which the context shows at once to be an error. Take an instance, where Manasseh is spoken of, in 2 Kings xxi. 3. "He reared up altars for Baal, and made a *grove*, as did Ahab king of Israel; and worshipped all the host of heaven." And in the 7th verse, "And he set a graven image of the *grove* that he had made in the house," *i.e.*, the Temple of Solomon. If by the word "grove" trees had been intended, then there would be but little meaning in these passages; but

* On a tablet we find "The cedar beloved of the great gods," which seems to refer to this device.

a floral symbol of Astarte called Asheerah could be quite understood, as well as God's anger with the people for adopting this particular kind of Assyrian idolatry. When giving one of my lectures at the British Museum, and mentioning these things as we were standing before this slab, the Bishop of Llandaff told us that the new version of the Old Testament would have the correction I was suggesting, which we were all pleased to hear.

If spared, I hope shortly to recommence these lectures in the Assyrian Galleries at Russell Street, and in the Geological Galleries at South Kensington; and in saying this I must repeat the high appreciation of myself and my friends for the great courtesy and kind attention which we have always received from Dr. Edward A. Bond, the Chief Librarian, Sir Richard Owen, Dr. Samuel Birch, Mr. John T. Taylor, and Mr. T. Nichols.

Some infidel lecturers are making a special point of dilating upon the imperfections and sins of the patriarchs. How one pities these poor fellows, who do not see that if Abraham, Jacob, Moses, David, Solomon, and the other eminent men of the Bible had been represented as perfect men, we should certainly have looked upon the stories of their lives as fictions. But as we find them men with like passions and failings as ourselves, we can feel assured of the truthfulness of the accounts. Moreover, if it had not been revealed to us that they had often erred, something like despair would come over us when reviewing our past lives and recalling our many shortcomings and sinful actions. We find, however, that these men, notwithstanding their defects, loved God sincerely, and were accepted and forgiven.

CHAPTER II.

"We have seen His Star in the East."

In my next chapter you will find I have mentioned the star of a particular constellation shining brightly at the birth of our Saviour, and thus attracting the attention of the "wise men," and you will see that I have good reasons for the supposition.

These men were evidently both learned and wealthy, and generally called *Magi*, from the Greek *μάγοι*, a title which, Kitto says, originally belonged to the priests, who were also the learned men of Persia; afterwards it came to have a more extensive application to all persons who cultivated science and learning, divine or human.

The magians gave much attention to the study of astronomy; and though some of them mixed up with it astrology, others were devout students of the heavenly bodies. That these eminent visitors to Bethlehem were of the latter school there can be no doubt, and perhaps they had read in the constellations symbolical prophecies of the coming of Christ, and instantly noticed the remarkable phenomenon which caused them to hasten off to Jerusalem. It seems most likely that they came from Persia, where science was at those periods much fostered; and they were not necessarily Jews, for we have many incidental evidences throughout the whole of the Old Testament history to prove that God-fearing men dwelt in every country.

Almost up to the present time, the signs of the Zodiac and

the figures representing the constellations have been thought mythical and even absurd; but I shall hope to show you that there is a depth of meaning in them which has been quite forgotten and disregarded for many, many years. You will remember that in my chapter on the creation of man I threw out the hint that God probably communicated to Adam a knowledge of the celestial luminaries; in the sequel I think you will find that such probability amounts almost to a certainty.

Cassini thus commences his "History of Astronomy":—"It is impossible to doubt that astronomy was invented from the beginning of the world: history, profane as well as sacred, testifies to this truth."

Bailly and others have asserted that astronomy must have been established when the summer solstice was in the first degree of Virgo, and that the solar and lunar zodiacs were of a similar antiquity. This would be about 4,000 years before the Christian era. These astronomers suppose this science to have originated with some ancient and highly-civilised people who lived at the time in about latitude 40°, but who were swept away by some sudden destruction, leaving, however, traces of their knowledge behind them.

Sir William Drummond says: "The fact is certain that at some remote period there were mathematicians and astronomers who knew that the Sun is the centre of our system, and that the Earth, itself a planet, revolves round it." And Mrs. Somerville says that every circumstance concurs to show that astronomy was cultivated in the highest ages of antiquity.

In connection with these statements it is intensely interesting to find that Josephus, in his "Antiquities of the Jews," lib. I., cap. ii., § 3, says:—

"Now this Seth, when he was brought up and came to those years in which he could discern what was good, became

a virtuous man; and as he was himself of an excellent character, so did he leave children behind him who imitated his virtues. All these proved to be of good dispositions. They also inhabited the same country without dissensions, and in a happy condition, without any misfortunes falling upon them till they died. *They also were the inventors of that peculiar sort of wisdom which is concerned with the heavenly bodies, and their order.*"

This last sentence is most remarkable, and would seem to imply that Seth invented the constellations, of which there is a singular confirmation in the writings of Origen, A.D. 230, in which he tells us that in "the Book of Enoch" it is asserted that the constellations were in that patriarch's time already divided and named.

St. Jude had evidently seen this book, for he says: "*And Enoch also, the seventh from Adam, prophesied of these, saying, Behold, the Lord cometh with ten thousands of his saints.*" How such a work could be preserved notwithstanding the Deluge has long been a problem to Biblical students; but since the discovery of Assyrian tablets dating back almost to the time of Noah the difficulty has been greatly cleared away; for it might have been that Enoch's prophecy was written on such a tablet, and possibly was taken into the ark itself. History tells us that St. Jude travelled in Mesopotamia, Armenia, and Persia; and in one of those countries he may have seen such a tablet, and indeed it is not impossible that a copy of it may yet turn up amongst the treasures exhumed from the long buried-up cities of Assyria.

If, therefore, the existence of the Book of Enoch could be proved, the links in the chain of evidence would render it probable that Seth invented the constellations, and that the grand old antediluvian patriarch possessed high scientific knowledge, and such regal authority as not only to command the veneration of his family, but to project his teaching downwards through successive generations, and to

invest it with a sanctity which still continues in our own times, sixty centuries afterwards.

This sanctity attached to these signs throughout all ages it would be difficult to account for, except upon the supposition that they contain mysterious truths intended to be thus handed down from generation to generation. What these truths were I will now endeavour to explain; but before doing so, I must gratefully acknowledge the help I have received from a work called "Mazzaroth," by Miss Rolleston, of Keswick, who was not only an earnest Christian, but also an Oriental scholar; and also from another book, "Primeval Man Unveiled," by Rev. James Gall, which has interested me greatly; for though I do not quite agree with all its propositions, it has amply repaid me for a careful perusal, containing as it does a considerable amount of original thought.

It seems evident that the whole of the zodiacal signs and ancient constellations were originally intended to teach mankind the scheme of Redemption; for conspicuous over the whole, and characteristic of all the rest, shines out the promise of Eden, that the seed of the woman was to bruise the head of the serpent, and in the conflict to be wounded.

It is worthy of notice that not only the figures in the constellations, but the very names of the chief stars seem to form the articles of the antediluvian creed.

If so, in the absence of a printed literature it was a magnificent idea to inscribe these doctrines upon the starry sky, and link them with the discoveries of astronomical science; so that the heavens might declare the glory of God, and that these precious doctrines might be handed down from father to son, and from sage to sage, without any one daring to change them.

I shall only introduce a few specimens of these antediluvian prophecies; and must first notice that before the time of

XV.—Virgo, showing the star Spica Virginis on the ears of corn, and above Virgo the original decan "Coma."

Moses the year of the Hebrews began, and still begins, with the entrance of the Sun into Virgo. I think I shall, therefore, have no difficulty in pointing out the evangelical meaning of the sign, as figured by the antediluvian prophet and enlarged upon by Isaiah (vii. 14), "*Behold, a virgin shall conceive, and bear a son, and shall call his name Immanuel.*"

If my readers will look at their celestial globes, they will notice that Virgo is represented as a woman fallen prostrate on the ground, grasping in one hand ears of corn, in the other a palm-branch, indicative of victory. Notice also that the brightest star in the constellation is not in the woman, nor in the palm-branch, but in the ear of corn, representing the promised seed, and now called *Spica Virginis*, in Arabic *Al Zimach*, the Branch or Shoot. It seems therefore apparent that this sign was intended to teach the miraculous birth of Christ, and that it was so considered by all his descendants throughout the world.

The engraving (Plate XV.) can be relied upon as a correct representation of this sign, which, by the kind permission of Mr. Gall, I have copied from his "Primeval Man," and have verified it by a reference to ancient and other drawings.

Balaam doubtless referred to the symbolical meaning of the chief star in this constellation when he said, "There shall come a Star out of Jacob, and a Sceptre shall rise out of Israel" (Numb. xxiv. 17). And Christ Himself tells us that He was that star; for we read in Rev. xxii. 16, "I, Jesus, have sent mine angel to testify unto you these things in the churches. I am the root and the offspring of David, and the *bright and morning star.*"

It is not improbable that the pious Magi, when watching this constellation to which so much veneration was attached, saw Spica Virginis shine out with a remarkable and increased splendour, which probably the light of the Sun did not extinguish in the daytime; for notice, they say, "We

have seen *His* star in the East." Why "His star," unless they meant some special one which had always been considered a symbol of Christ's advent?*

Miss Rolleston says that Zoroaster, who taught astronomy to the Persian Magi of his time, had told them that when they should see a star appear in the figure of the Virgin, they should go and worship the Great One whose birth it announced. It is thought that Zoroaster was the disciple of Daniel; if so, he would be acquainted with Daniel's prophecy of the seventy weeks of years.

From the text I do not think that the star guided them to Jerusalem, but that they travelled thither to see whether the brightness of the star indicated that the glorious event predicted had really come to pass.

Their great joy, also, when they saw the star again, after they left Herod, is a proof that they had not seen it for some time. In this latter case, however, it must have been some supernatural light in the sky which led them to Bethlehem.

Does not this view of the subject enhance the charming story of the visit of these learned men? And does it not also give beautiful meanings to these astronomical symbols?

There is one thing more to notice about this constellation, which is that the woman has wings, to mark her original dignity. On some modern globes a sickle is placed in the right hand instead of a palm-branch; this is a sad corruption, and has been thus altered by some one quite ignorant of the original meaning of the sign.

Each sign of the zodiac is accompanied by three other constellations, called decans, the first of which connected with Virgo is that now called *Coma Berenices,* but originally represented by a young woman holding an infant in her lap.

This had been corrupted by the Alexandrian astronomers,

* Upwards of one hundred stars are known of variable lustre, and though this is not amongst them, we can understand the possibility of its brightness *being increased* at that particular time.

who changed the Oriental "*Coma*," meaning "the desired" or "longed for," into the Greek "*Comē*" (κόμη), "hair;" and instead of the Virgin with "the longed-for child," they drew it in the form of a wig. Albumazer,* however, who lived in the ninth century, says: "There ariseth in the first decan,

Fig. 91.—Egyptian Signs of the Zodiac.

as the Persians, Chaldeans and Egyptians, the two Hermes and Ascalius teach, a young woman whose Persian name translated into Arabic is Adrenedefa, a pure and immaculate virgin, holding in the hand two ears of corn, sitting on a throne nourishing an infant, in the act of feeding him, who has the Hebrew name (the boy, I say) by some nations named *Ihesu*, with the signification *Ieza*, which we in Greek call Christ."

* A great Arab physician and astronomer.

This was written a thousand years ago, and Albumazer particularly mentions that the ancient authorities which he had studied taught that such was the symbol in this decan; and it is rather singular that Shakespeare must in some way have known it, for in *Titus Andronicus* he speaks of an arrow being shot up to the "Good boy, in Virgo's lap" (Act iv., sc. 3).

Denon, a *savant* attached to the expedition of the first Napoleon, in his "Voyages dans l'Egypte" gives drawings of two zodiacs he found at Dendera, and on the circular one this decan "Coma" is represented as a woman with a child, which I think settles the question of its antiquity.

Fig. 91 is a copy of that portion of this Egyptian planisphere which contains the twelve signs. Please to notice the woman is carrying a palm-leaf or ears of corn.

Now let us examine the next sign, Libra; and these balances were, probably, intended to teach the justice of God. The chief star in the constellation is *Zuben al Geneb,* which means in Arabic "the price that is deficient," and surely records the verdict of man's condemnation. Thus the antediluvian theology, as well as the Christian, commences by including all men under sin, and having no righteousness of their own by which they may be justified. This, too, will correspond with Daniel's solemn address to Belshazzar, "Thou art weighed in the balances, and art found wanting."

Doubtless many of my readers have in elementary books seen this zodiacal sign explained as referring to our having equal days and nights when the Sun enters Libra; but no such idea could have been intended, for in consequence of the precession of the equinoxes the Sun would not be in Libra at the autumnal equinox in that early age of the world.

The next sign is Scorpio, signifying death as the penalty of sin; and if you look above it you will see the figure of a man (Ophiuchus) grappling with a serpent and strangling it, *whilst he is* treading on the scorpion's head, which is wounding

XVI.—Scorpio. Ophiuchus treading upon its head, and being stung in his heel.

his heel with its sting. The brightest star in Scorpio is *Antares*, which means in Arabic "wounding."

When our Lord predicted the overthrow of Satan, He said, "Behold, I give unto you power to tread on serpents and scorpions, and over all the power of the enemy, and nothing shall by any means hurt you." Here the prophet's teaching was repeated by our Lord after four thousand years, and evidently was quite understood by the apostles. (Plate XVI.)

The next sign is Sagittarius, who is shooting toward Scorpio, or Death, to destroy him; and the twofold nature of Sagittarius would probably represent the divine and human natures of Christ.

Turn your globe round a little more, and Capricornus, a goat, appears, which in some old drawings is represented as if fainting or dying. The goat, being a sacrificial animal, was meant to teach that the Messiah should suffer and die; and as the lower part of the body is that of a fish, the union of Christ with His Church was indicated; for fishes in both the Old and New Testament signify multitude, and are frequently applied to those converted to the Gospel. "I will make you to become fishers of men" was the promise given to the apostles by our Lord, and amongst the early Christians fishes were the well-known symbol of the Church. In the other constellations the same interpretation is always attached to them. It is rather remarkable also that the fish which terminates the body is in lively action; therefore we see the atonement represented by the death of the sacrifice, and the life of the Church represented in its union with Christ. In the days of persecution the early Christians frequently made themselves known to each other by the fish engraven on their rings, signifying they were baptised believers. It was also sometimes sculptured on their tombs, as may be seen in the catacombs.

Now comes an important circumstance in connection with

this constellation; the chief star is *Al Dabih*, meaning "the sacrifice slain;" this seems to remove all doubt as to the true meaning, and was intended to teach the antediluvians that the Messiah should suffer and die.

The two following signs seem still more remarkable. Aquarius is represented by a water-bearer, who is holding a water-pot, from which a stream is flowing, and in order to show its destination it is represented as entering into a fish called Piscis Australis, one of the decans of the sign.

Is not this a type of the outpouring of the Holy Spirit on the Day of Pentecost, and the water flowing into the mouth of a fish symbolical of His entering into the Church? Still more interesting is the fact that the other two decans of this sign are the Flying Horse and the Flying Swan; intimating the carrying of the Gospel of Christ over land and water to all nations after the Pentecostal shower.

The constellation Pisces is represented by two fishes, which are united by a starry band representing the bonds of peace and love which unite the Gentile and Jewish Churches of Christ; and what is exceedingly interesting is that this ribbon is frequently extended and carried into the next sign, Aries, which was originally represented as a male lamb, and in its fore foot it holds the ribbon that connects the two signs, showing that these Churches are united to Christ, and that He is keeping them in His charge; and, again, to confirm this interpretation, both these ideas are represented in the stars of this constellation, *Okda* in Hebrew meaning "united," and in Arabic *Al Samacha*, "the upheld."

If Josephus be really right in attributing to Seth or his children the invention of these signs and symbols, then indeed we have a most remarkable insight into the antediluvian theology, and must be struck by its fulfilment in the New Testament times, and the extraordinary confirmation it is of *the Divine* origin of the whole Bible.

That Adam, Seth, and Enoch were the great prophets of the antediluvian age there can be but little doubt, for Zacharias said, "Blessed be the Lord God of Israel; for He hath visited and redeemed His people, and hath raised up a horn of salvation for us in the house of His servant David; as He spake by the mouth of His holy prophets, *which have been since the world began.*" These last words can only mean that prophecy commenced with Adam himself.

It will be very easy for us to understand that this sublime teaching of the antediluvian prophets was perverted to an adoration of the symbols, and followed by an idolatrous worship of the heavenly bodies. Also astrology would have its origin in the perversion of the prophecy of the advent of our Lord to prognostications of the destinies of men.

Another very important point also gained is the discovery of the origin of the Brahminical and other spurious imitations of the Trinity, which are brought forward by sceptics as arguments to show that other religions of great antiquity teach similar doctrines to our own, and therefore that their followers may be as much in the right as we are. If we carry back to Adam, Seth, or Enoch the invention of these symbols and their spiritual teaching, and can show that other ancient countries have venerated and preserved them, then it is as clear as possible that their systems of faith were originally founded upon them and have since become grossly perverted.

Whilst thinking over this chapter, a circumstance occurred which seemed to me to amount almost to a special providence, for I was directed to look in the *Philosophical Transactions* for 1772, and there I found a letter to the Astronomer Royal, Dr. Nevil Maskelyne, F.R.S., from Mr. John Call, dated July 8, 1764, containing a sketch of the signs of the Zodiac found by him on the ceiling of a pagoda near Cape Comorin in India.

It would appear from Virgo being repeated and placed in

the centre, that it was the summer solstitial sign when the figures were first drawn, and that, astronomers well know, must have been about 6,000 years ago (Fig. 92). This is indeed remarkable, for it carries us right back to those early times, and thereby strongly confirms the origin I have given.

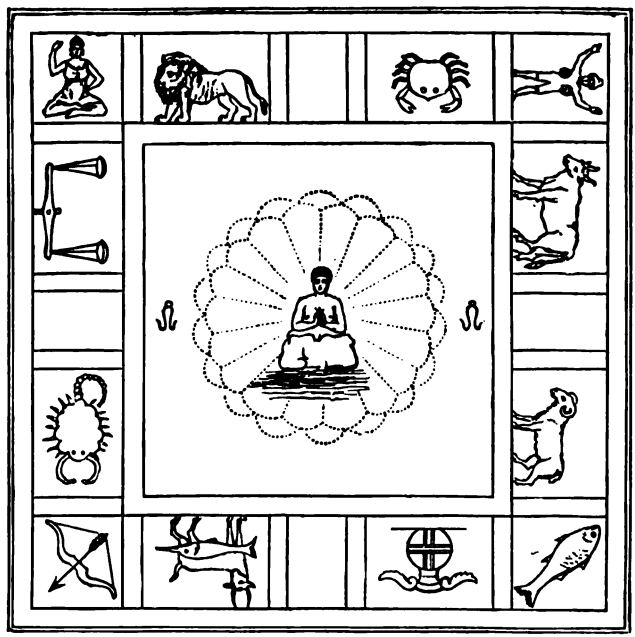

Fig. 92.—Indian Zodiac, from the *Philosophical Transactions*, 1772.

Pray notice that the water-pot is inscribed with a cross and has wings attached to its rim. (See page 430.)

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CHAPTER III.

"He hath redeemed us."

In a former chapter I described the delights of Eden; but, alas! our first parents forfeited that high estate by disobedience. It was a sad, sad day when they fell, and very dark were the clouds which hung over them when God turned them out of their Paradise, and placed angelic sentinels at its entrance "and a flaming sword" to prevent them again entering within the sacred enclosure.

Still they were not left in utter despair, but the marvellous scheme of Redemption was communicated to them as the only way in which they could obtain pardon; and that Adam sincerely repented, and accepted the proffered salvation by believing in the Saviour to come, there can be no doubt.

Eve also was equally contrite, and believed the promise that was given her, that she should be ancestress of the Messiah. How touchingly beautiful is Milton's description of their humiliation:—

> "So spake our father penitent, nor Eve
> Felt less remorse. They forthwith to the place
> Repairing where He judged them, prostrate fell
> Before Him, reverent, and both confess'd
> Humbly their faults, and pardon begg'd, with tears
> Watering the ground, and with their sighs the air
> Frequenting, sent from hearts contrite, in sign
> Of sorrow unfeign'd, and humiliation meek."
>
> (*Par. Lost*, bk. x., 1,097.)

They had both fallen, but they still loved their God; and *without* repining at their merited expulsion from Paradise,

were grateful for all their present and future blessings; for though but little is said about them, that little bespeaks their piety.

When Cain was born, Eve burst forth into joyful praise, saying, "I have gotten a man from the Lord;" then Abel followed, and we find them early taught to worship God; and as an evidence of Abel's faith in the promised Saviour, he offered a sacrifice that was emblematical of the Divine atonement.

Both sons had seen their parents devoutly worship God, and had also seen the visible sign of God's acceptance of their sacrifices; hence it was that Cain, noticing the approval of his brother's offering, was jealous and angry because the same manifestation was not vouchsafed to him; not considering, as he ought to have done, his own want of obedience in the kind of offering, and the spirit in which it should have been brought. The remainder of the story is truly sad; but soon we read of Seth, and again Eve sends up to heaven her voice of praise and gratitude; in Seth and his descendants she was greatly comforted, for "then began men to call upon the Lord."

So holy, indeed, were some of the posterity of our first parents that one of them, Enoch, was taken up to heaven without dying, because he had "walked with God." And, according to the chronology, Adam and Eve were both alive in the early part of Enoch's life, although they had died before his translation.

It is often asked, Could not God have preserved man from this sad fall and from all the attendant evils connected with it? Doubtless He could have done so; for as He has made the bee a most skilful geometrician without its having the slightest capacity of forming its cells otherwise than perfect, therefore He could, if He had pleased, have made man utterly incapable of doing evil; but then he would

This was written a thousand years ago, and Albumazer particularly mentions that the ancient authorities which he had studied taught that such was the symbol in this decan; and it is rather singular that Shakespeare must in some way have known it, for in *Titus Andronicus* he speaks of an arrow being shot up to the "Good boy, in Virgo's lap" (Act iv., sc. 3).

Denon, a *savant* attached to the expedition of the first Napoleon, in his "Voyages dans l'Egypte" gives drawings of two zodiacs he found at Dendera, and on the circular one this decan "Coma" is represented as a woman with a child, which I think settles the question of its antiquity.

Fig. 91 is a copy of that portion of this Egyptian planisphere which contains the twelve signs. Please to notice the woman is carrying a palm-leaf or ears of corn.

Now let us examine the next sign, Libra; and these balances were, probably, intended to teach the justice of God. The chief star in the constellation is *Zuben al Geneb*, which means in Arabic "the price that is deficient," and surely records the verdict of man's condemnation. Thus the antediluvian theology, as well as the Christian, commences by including all men under sin, and having no righteousness of their own by which they may be justified. This, too, will correspond with Daniel's solemn address to Belshazzar, "Thou art weighed in the balances, and art found wanting."

Doubtless many of my readers have in elementary books seen this zodiacal sign explained as referring to our having equal days and nights when the Sun enters Libra; but no such idea could have been intended, for in consequence of the precession of the equinoxes the Sun would not be in Libra at the autumnal equinox in that early age of the world.

The next sign is Scorpio, signifying death as the penalty of sin; and if you look above it you will see the figure of a man (Ophiuchus) grappling with a serpent and strangling it, whilst he is treading on the scorpion's head, which is wounding

No: he is on the bench to carry out the law, and he must do it even if his own son stands before him, and any other course on his part would be simply criminal.

Thus we see that God must not only punish the sinner, but must accord the punishment with infinite exactitude according to the infinite perfection of His justice. If man, therefore, is to be saved it must be according to law, and by means which are consistent with the most perfect justice; for unless God can be just at the same time that He pardons the ungodly, man's salvation would be altogether impossible. There is then only one solution of the difficulty—

God's Scheme of Redemption.

How shall I enter upon this theme, so mysterious and yet so glorious! Many times in writing this book have I feared that I might fail in doing justice to the important work I had undertaken, and now I feel my weakness indeed.

We have the clearest and most certain revelation that redemption was conceived and planned in the Almighty mind before the commencement of the world. He knew that if He made man a free agent he would not unfrequently break His laws, and as no other than an infinite atonement could satisfy the claims of His infinite justice, He in His infinite love pre-ordained this plan of redemption. This grand scheme was, as I have said, very early communicated to man, and we find that from the beginning to the end all the teachings of the Old Testament tend towards this consummation of man's salvation. It is not my intention, however, to refer to the many wondrous and important prophecies with which it abounds, as so many excellent works have been written upon them; but I shall content myself with having given you in the preceding chapter what I hope *you will* consider interesting information upon the evidence

his heel with its sting. The brightest star in Scorpio is *Antares*, which means in Arabic "wounding."

When our Lord predicted the overthrow of Satan, He said, "Behold, I give unto you power to tread on serpents and scorpions, and over all the power of the enemy, and nothing shall by any means hurt you." Here the prophet's teaching was repeated by our Lord after four thousand years, and evidently was quite understood by the apostles. (Plate XVI.)

The next sign is Sagittarius, who is shooting toward Scorpio, or Death, to destroy him; and the twofold nature of Sagittarius would probably represent the divine and human natures of Christ.

Turn your globe round a little more, and Capricornus, a goat, appears, which in some old drawings is represented as if fainting or dying. The goat, being a sacrificial animal, was meant to teach that the Messiah should suffer and die; and as the lower part of the body is that of a fish, the union of Christ with His Church was indicated; for fishes in both the Old and New Testament signify multitude, and are frequently applied to those converted to the Gospel. "I will make you to become fishers of men" was the promise given to the apostles by our Lord, and amongst the early Christians fishes were the well-known symbol of the Church. In the other constellations the same interpretation is always attached to them. It is rather remarkable also that the fish which terminates the body is in lively action; therefore we see the atonement represented by the death of the sacrifice, and the life of the Church represented in its union with Christ. In the days of persecution the early Christians frequently made themselves known to each other by the fish engraven on their rings, signifying they were baptised believers. It was also sometimes sculptured on their tombs, as may be seen in the catacombs.

Now comes an important circumstance in connection with

this constellation; the chief star is *Al Dabih*, meaning "the sacrifice slain;" this seems to remove all doubt as to the true meaning, and was intended to teach the antediluvians that the Messiah should suffer and die.

The two following signs seem still more remarkable. Aquarius is represented by a water-bearer, who is holding a water-pot, from which a stream is flowing, and in order to show its destination it is represented as entering into a fish called Piscis Australis, one of the decans of the sign.

Is not this a type of the outpouring of the Holy Spirit on the Day of Pentecost, and the water flowing into the mouth of a fish symbolical of His entering into the Church? Still more interesting is the fact that the other two decans of this sign are the Flying Horse and the Flying Swan; intimating the carrying of the Gospel of Christ over land and water to all nations after the Pentecostal shower.

The constellation Pisces is represented by two fishes, which are united by a starry band representing the bonds of peace and love which unite the Gentile and Jewish Churches of Christ; and what is exceedingly interesting is that this ribbon is frequently extended and carried into the next sign, Aries, which was originally represented as a male lamb, and in its fore foot it holds the ribbon that connects the two signs, showing that these Churches are united to Christ, and that He is keeping them in His charge; and, again, to confirm this interpretation, both these ideas are represented in the stars of this constellation, *Okda* in Hebrew meaning "united," and in Arabic *Al Samacha*, "the upheld."

If Josephus be really right in attributing to Seth or his children the invention of these signs and symbols, then indeed we have a most remarkable insight into the antediluvian theology, and must be struck by its fulfilment in the New Testament times, and the extraordinary confirmation it is of *the Divine* origin of the whole Bible.

That Adam, Seth, and Enoch were the great prophets of the antediluvian age there can be but little doubt, for Zacharias said, "Blessed be the Lord God of Israel; for He hath visited and redeemed His people, and hath raised up a horn of salvation for us in the house of His servant David; as He spake by the mouth of His holy prophets, *which have been since the world began.*" These last words can only mean that prophecy commenced with Adam himself.

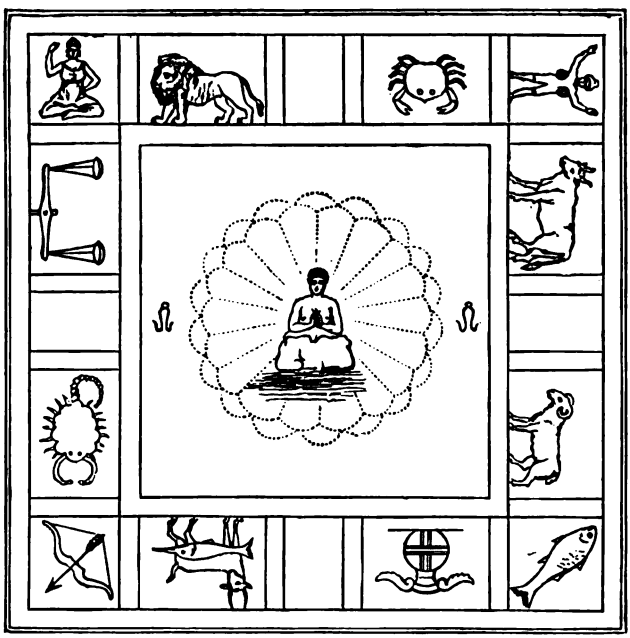
It will be very easy for us to understand that this sublime teaching of the antediluvian prophets was perverted to an adoration of the symbols, and followed by an idolatrous worship of the heavenly bodies. Also astrology would have its origin in the perversion of the prophecy of the advent of our Lord to prognostications of the destinies of men.

Another very important point also gained is the discovery of the origin of the Brahminical and other spurious imitations of the Trinity, which are brought forward by sceptics as arguments to show that other religions of great antiquity teach similar doctrines to our own, and therefore that their followers may be as much in the right as we are. If we carry back to Adam, Seth, or Enoch the invention of these symbols and their spiritual teaching, and can show that other ancient countries have venerated and preserved them, then it is as clear as possible that their systems of faith were originally founded upon them and have since become grossly perverted.

Whilst thinking over this chapter, a circumstance occurred which seemed to me to amount almost to a special providence, for I was directed to look in the *Philosophical Transactions* for 1772, and there I found a letter to the Astronomer Royal, Dr. Nevil Maskelyne, F.R.S., from Mr. John Call, dated July 8, 1764, containing a sketch of the signs of the Zodiac found by him on the ceiling of a pagoda near Cape Comorin in India.

It would appear from Virgo being repeated and placed in

the centre, that it was the summer solstitial sign when the figures were first drawn, and that, astronomers well know, must have been about 6,000 years ago (Fig. 92). This is indeed remarkable, for it carries us right back to those early times, and thereby strongly confirms the origin I have given.



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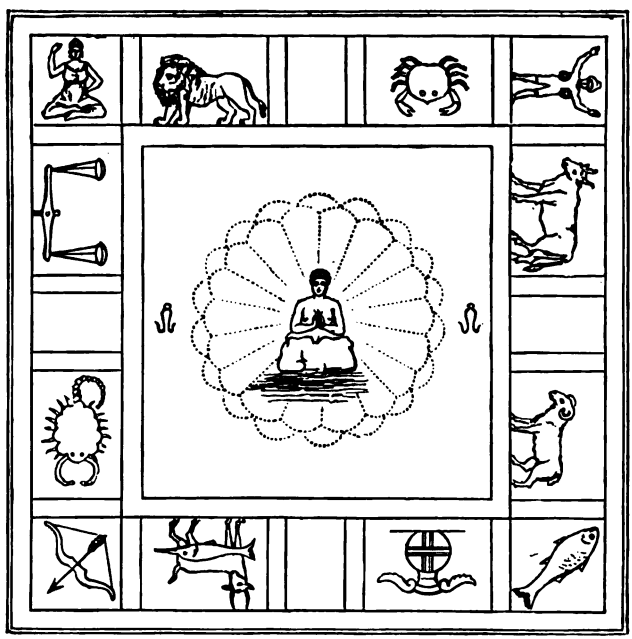

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And could not He who was acquainted with all the laws of Nature have so moved the secret springs that miraculous results should be the consequence? Undoubtedly.

Hence, then, we see that His life and conduct were such as to prove the genuineness of His mission, which was still further confirmed by the manifestation of His supernatural power.

This being the case, He could be none other than the Messiah and the Saviour of the world, and as such let us look at Him in the Garden of Gethsemane, where the whole weight of man's transgressions pressing upon Him caused Him to suffer a mental agony so great that "His sweat was as it were great drops of blood falling down to the ground." In those bitter moments He for the first time prayed that the cup might pass from Him; but though almost crushed with the infinite load of man's guilt, He added, "Not my will, but Thine, be done;" and then arose, and calmly went through all the cruel tortures of the scourge and cross.

At the sixth hour the sun's rays were hidden by a dense cloud, and darkness hung over Jerusalem. Whilst this propitiatory sacrifice was being offered, God also had so withdrawn His presence from His beloved Son that He cried out in the bitterness of His soul, "My God, my God, why hast Thou forsaken me?" It was then that the struggle was the most severe between the powers of Heaven and Hell, and continued until the ninth hour, when one more ejaculatory expression escaped the lips of the dying Saviour—

"*It is finished.*"

Thus was Satan vanquished, man redeemed, and the law satisfied. On the third day the glorious resurrection completed the triumph, and thenceforth whosoever believeth on Him shall be saved.

God grant that all who read this book may be able to exclaim with the Apostle Thomas, "My Lord and my God!"

CHAPTER IV.

"Thy Prayer is heard."

On reading our Saviour's life it must have struck every one as being very remarkable that He spent so much time in prayer, and on one occasion we find that even a whole night was occupied in that holy exercise. When a young lad I could not at all understand this, for it seemed to me inconsistent with His Godhead that He should offer any prayers whatever. But now those difficulties have passed from my mind, and I can see that as a son He would necessarily hold communion with His Divine Father in this special manner; and the beautiful prayer which St. John has preserved for us in the 17th chapter of his Gospel so clearly shows His relationship to God that no one, I think, could read it carefully without understanding that relationship, and seeing the whole scheme of man's redemption most fully set forth, as well as the glorious position our Lord occupied "before the world was."

The language also is so full of sublimity and pathos that whilst it brings out the Divinity of our Lord in bold relief, it also shows His tenderness and love for those He came to save. But His prayers had another object besides that of personal communion with His Heavenly Father. He had continually enjoined on His disciples to "watch and pray," and He set them the example of doing both these things. This leads me to the consideration of this subject, and to show that—

Answers to Prayer are in Accordance with Law.

Those who do not accept the inspiration of the Bible make it one of their chief objections to the efficacy of prayer that the laws of Nature are eternal, and could not be modified or altered to suit the necessities or desires of any creature, and that, therefore, it is presumptuous folly to pray for temporal blessings.

First, we must ask our opponents for their proofs that the present natural laws are eternal. That God must have existed from all eternity is certain, and that He must also from His very nature have been always active is equally certain; but whether He has from eternity governed the universe by the same laws it is impossible for any one to say.

Next, we must ask them how they can prove that any special providential supply of our natural wants is contrary to law; their reply would be something of this kind:—Two men living in the same locality might have different crops which would require different kinds of weather; and as the perfection of those crops would be a direct necessity to each farmer, so each might pray for an opposite kind of blessing; and as it is evident if one received an answer to his prayer the other could not, therefore the whole theory is certainly absurd. I am sure many have heard almost these very words used, with a sort of triumphant flourish, as much as to say, "There now, you cannot get over that!"

These sophists do not know that a man who really and sincerely prays from his heart does so in perfect resignation to God's will, and selfishness would form no part of his petition. Therefore, if these two farmers were godly, praying men, they would each think of the welfare of his neighbour, and would desire that the weather might be propitious to them both; and with these feelings, whatever happened, they would not only be resigned to God's will, but would receive such a

blessing that each would rejoice in the other's success; and the Great Governor of the Universe might so temper the weather that sunshine and showers would be so alternated that, after all, both crops would be gathered in excellent condition. And if this did not happen, then each would still receive an answer by enjoying that peace of mind which always accompanies perfect resignation to God's will.

The next remark would be, "Then you really mean to say that God would actually, by a miraculous intervention, alter some natural law for the benefit of a single individual who is but an insignificant atom in creation?" Nay, I do not say that He would by a miracle alter some law for the special benefit of an individual; but in order to provide for the promised answers to prayer I fully believe that special laws have been ordained.

Do not start at this assumption, and close the book without giving the matter sufficient thought. I have shown before that there are many laws which do not come into operation until man has taken the initiative.

Take as an instance a wild flower growing in the fields without much variety or beauty. A gardener selects several plants and places them in suitable soil, crosses the pollen of the few varieties in existence, and obtains seedlings which are far superior flowers to the original plants. Again he continues the plan of inoculation and culture, and other seedlings are the result, still more beautiful; until he obtains endless varieties with still-increasing beauties, displaying every tint of the rainbow with the most exquisite shading-off of every possible hue.

Now here we see the laws of variation and beauty set into operation by the hands and intellect of man; but let me take one more instance of a law not being in actual operation until circumstances transpire to call it forth.

A man breaks his leg, and at once a special law comes

into operation, which causes a greater secretion of the phosphate of lime about the fracture, and not only unites the broken part, but in some cases actually forms a ferule of bony matter around it. Is not this a marvellous piece of mechanism, to be so arranged that if a portion of it becomes broken or injured, it has within itself mechanical and chemical arrangements for repairing such an injury immediately it takes place?

To fully understand this, we must conceive of a watch so constructed that if the chain or a wheel broke, a series of small hammers and rivets would be instantly set in motion to repair the mischief.

I have read of a hen which broke its leg, and while it was becoming repaired by this natural law, its egg-shells had no lime in them, as an extra quantity was required for mending the fractured bone.

Well, then, here we have a most remarkable law which only comes into operation when an accident occurs to the animal frame; and in the case of a man who never breaks any of his bones, such a law would not come into operation during his whole life.

From all this I would reason that there are many laws which are, as it were, dormant, until called into operation either by some direct act on man's part, or by some special circumstance which sets the wheels of such laws in motion.

Why, then, should not the act of prayer call into operation certain laws quite unknown to the most eminent physicists, which laws should bring about answers to those prayers either spiritually or temporally? We find in that wonderful and beautiful model given us by Christ that we are taught to ask for our daily bread; and would not this also indicate that it was lawful and right to pray for propitious weather, upon which the supply of our daily bread depends; and should we *be instructed* thus to pray if provision had not been made for

direct answers to be given, and that by definitely ordained laws which supersede all others?

Surely we can read a lesson in the diffusion of gases which ought to teach us that, however universal a law may be, another may be ordained superior to it.

What could be a more universal law than gravitation? and yet, if gases were obedient to it, we should soon all be poisoned with the heavy carbonic acid which would then form a thick layer all round the globe. But the law of the diffusion of gases being superior, this and other noxious gases ascend, whilst those that are lighter, equally in opposition to gravitation, descend; hence carbonic acid gas is found in the atmosphere, at the top of the highest mountains, and hydrogen, twenty-two times lighter, is found in the deepest mines.*

Who shall say, then, that laws are not in existence which shall equally supersede all those in general operation, and when a man prays to his God, his Creator, his Heavenly Father, may he not set in motion a superior law, whereby definite results are produced?

The answers, therefore, to a man's prayers may not be deviations from fixed laws, but in accordance with special laws appointed and ordained for the purpose from the first. Let us now give a few illustrations of this subject.

A few years ago, the sudden and dangerous illness of the Prince of Wales created a sensation of deep anxiety and alarm, not only in the British Isles, but throughout the world; and as the deadly disease advanced in its various stages, this anxiety increased to such an extent that a universal gloom spread over the country. It was then seen what an amount of loyalty there was in every Englishman's heart—yea, even those who had talked before in the strongest democratic strains now found that their words and their real sentiments

* See page 89.

differed widely. The Royal Prince and heir to our throne had won the hearts of all persons by the deep interest he had taken in our institutions, charitable, scientific, and literary. Wherever he went, his genial presence had always thrown a beam of sunshine upon the assembly, and every one had felt brighter and happier because the Prince was there. Honoured as our future King, esteemed as a perfect English gentleman, and beloved for that goodness of heart which he invariably manifested towards the highest peer and the lowliest peasant, but one feeling of the deepest grief pervaded all minds. Never shall I forget that Saturday night when every one was almost breathless with fear lest at any moment a telegram should arrive with the fatal news; and Sunday morning came, bearing with it but little hope, yet still the Prince lived, and then all the world bowed down before the Throne of God, praying from the bottom of their hearts for the prolongation of so precious a life. The loving and beloved Princess, too, left for a short time the sick-couch of her husband, and went up to the house of the Lord to join in the universal prayer.

In the church, in the chapel, in the synagogue, in the mosque, yea, even in the Brahminical temple, the same prayer was sent up to Heaven. And it was heard and answered, for before that Sunday had passed slight symptoms of improvement were noticed, and on Monday morning hope beamed on every face. Each day better news arrived, and at length we had our Prince again amongst us, whose first public act was to go with his Royal Mother to God's sanctuary to offer up a thanksgiving for his great deliverance.

And was his health restored as a miracle? Not necessarily so, but an extra amount of wisdom might have been given to his physicians, so that the means they used for his recovery were effectual, even though the disease was apparently beyond all human skill.

There were many, very many, who up to that time dis-

believed in the efficacy of prayer, who then felt that this was a case where God had intervened to ward off the fatal blow; and many, many more who had trusted in the promise "that the effectual fervent prayer of the righteous man availeth much," were strengthened in their faith, confirmed in their belief, and encouraged in their Christian course.

From the palace I will now take you to a lowly cottage where resided a Christian man who had, from some cause, been thrown out of work. For a short time his little savings supported his family, and then pinching poverty began to stare them in the face. At last the cupboard was quite empty, and the children cried from hunger, whilst the patient mother sought by caresses to allay their sufferings.

Unable to bear the distressing sight, the man went out into the woods, and there alone with God he poured out his soul in supplication, not only that his family might be fed, but that they might be led to trust in their Heavenly Father. He went home refreshed, and as he opened the door he stumbled over something, and upon getting a light he found that it was a large bag containing a joint of meat, a quantity of bread, and many other articles of food which would last them all for several days.

At once he knew that his prayer had received a direct answer, but he also knew that it was not a miracle in the usual sense of the word, but that some one had been induced to send him those provisions. For some years the donor was unknown, until a rich and parsimonious man on his death-bed acknowledged that one day he was sitting down to dinner, when he suddenly thought of the poverty of this man, whose case he well knew; and though quite unaccustomed to works of charity, a sensation came over him which not only prevented him from eating his dinner, but urged him to send it all to this family, adding also to it sugar, tea, and other necessaries. Binding his servant over to secrecy, he told him

to pack it all up, and place it inside the poor man's door, and there he found it on his return.

This circumstance, which I believe to be a perfectly true one, proves that God can make even the most unlikely men His instruments to carry out His designs and fulfil His promises. Had the food been placed there by a charitable and good man, it might have been argued that it was only a coincidence, and not an answer to the prayer of the poor Christian; but such a man being compelled against his very nature to feed this family, shows most clearly that it was a special and direct interposition of Providence.

We must not, however, always expect direct answers to prayer, for we do not always know what is best for us, and what we ask for might not even be for our good. Therefore we must always pray with resignation to God's will, and then even if we do not appear to have an immediate answer, we shall receive that comfort which St. Paul experienced when he was told, "My grace is sufficient for thee."

Sometimes, also, when we think we have not been heard, circumstances turn out afterwards to show that a series of providences have, in a way we little expected, brought about even greater blessings than we could possibly have hoped for, as the following story will illustrate :—

A professional man, having several anxious cares upon his mind, was induced one Sunday evening to leave his usual church and attend the service at another. He heard a sermon which impressed him greatly from these words, "Be careful for nothing; but in every thing by prayer and supplication with thanksgiving let your requests be made known unto God." He came away greatly cheered, and, going down into the country for a little change and rest, threw off for a time all concern. One morning, however, he received at nine o'clock a letter requesting his presence in London, to meet at one o'clock some five gentlemen in reference to

important business matters. He was staying at the country-house of some kind friends about five miles from Birmingham, and on inquiring how he could get to London by one o'clock, was told that if he caught the next local train, he might get to Birmingham in time for the ten o'clock train, which would reach the metropolis at one. Everything depended upon the punctuality of the local train, and he felt at first not a little concerned as to its arrival. Then the text came into his mind, "Be careful for nothing," on which he determined to cast his care upon God, and to believe that whatever happened it would be for the best.

Birmingham was nearly reached at five minutes to ten, but a little delay occurring in taking the tickets, he saw the London train gliding out of the station just as the local one was going in. The opportunity was gone for keeping the appointment, and it being Saturday he knew it would be useless to go by a later train. Almost fainting, he went into the Exchange, and sat down to think what he should do, for the business was so important that not only thousands of pounds were connected with the transaction, but also much future comfort or the reverse.

After a few minutes' reflection, he sent off five explanatory telegrams, one to each of the gentlemen he was desired to meet, and fixed an early hour for being with them on the Monday morning; he then returned to the house of his friends. On reaching there a telegram was put into his hands containing very unfavourable news, but he was not utterly cast down, for the text was still ringing in his ears, or perhaps was being whispered into them by some kind angel. In the evening, on being asked by his host what was troubling him, he told him his whole story. At once this kind and wealthy friend tendered his services, and offered to go to London to see what he could do in the matter. You may be quite sure that this proposition was thankfully

accepted, and a few days after the whole business was arranged in a most satisfactory manner.

Now, had that gentleman caught the ten o'clock train to London, he would not have had the help of his friend, and perhaps would have utterly failed in the business. Therefore it was a reward for his faith thus to be led back to one who had both the will and the ability to do him so great a service.

Unbelievers in the efficacy of prayer will say that there can be no law ordained in reference to prayer, because so many petitions are offered that are not answered. Before they can establish this objection, they must first prove that the prayers to which they allude have been offered in a proper spirit; and, secondly, if they have been so offered, they must demonstrate to a certainty that no answer has been received.

Going back to the flower, would you say that no laws of variation and improvement by culture existed because of the many failures? Ask a gardener how many choice and beautiful plants he gets out of a hundred seedlings, and you will be surprised at the small percentage of his success; but these failures do not prove the non-existence of such laws. Something might be wrong in the soil, the pollen might not have been mature, and numbers of other physical reasons could be given for the production of imperfect and useless plants. So with prayer, perhaps some of the conditions necessary to ensure success might not have been complied with.

David says, "If I regard iniquity in my heart, the Lord will not hear me." A godless man has therefore no right to expect an answer to a prayer, perhaps only offered when trouble or danger has come upon him. Faith also is equally necessary, for Christ tells us, "Believing ye shall receive."

Next, we must ask for everything in His name. "Whatsoever ye shall ask the Father in My name, He will give it you." This, of course, is quite repudiated by the man

who will not admit of Christ being our Mediator. Nevertheless, if the Bible be true, there is no escaping from this condition, which must be complied with.

And, lastly, there must be a perfect resignation to God's will, and an entire confidence that He will, in His wisdom and love, do that which is most for our good, though it may not be what we desired or asked for.

With regard to the last condition being complied with, I know a striking instance. An eminent London physician who had attained to the highest position in his profession, and who was in every sense of the word a scholar and a gentleman, possessed also a most amiable and courteous disposition, which gained for him not only the esteem but the love of all who knew him. One of his patients used to say that he was as near perfection as it was possible for a man to be in this world.

In his family circle also he was the best of fathers and the most devoted of husbands. Well, it pleased God to lay upon him a sore affliction, accompanied with much bodily pain, which sometimes was agonising. Many and earnest were the prayers offered by those who loved him that he might recover. Month after month rolled by, and no improvement took place; but gradually, very gradually, he grew worse, so that it might have been said he was nearly six months dying. During all that time he never once repined, or uttered a single impatient complaint. I was amongst those who were privileged with his friendship, and indeed I loved him so well that his sufferings were a great grief to me.

One morning I received a note from his eldest daughter containing these expressive words: "My dear father has gone to his God whom he loved so well, and to whose will he always bowed."

Many, many times I asked myself why it was that so

good—I had almost said so perfect—a man was called upon to suffer so much, and then I felt it must have been in order that he might be to the world a pattern of resignation, and by his patience on his sick-couch show to unbelievers what Christianity could do in supporting and comforting a man under such a trial. He was "faithful unto death," and God has given him "a crown of life."

I had almost forgotten to notice that the unbeliever in the efficacy of prayer frequently brings forward the objection that man is too small an atom in the Universe for the Almighty Creator to consider specially his individual case. Such an objector quite forgets the infinity of God, who can sustain by His power ten thousand times ten thousand suns, and be cognisant of a monad a million times smaller than the point of a pin. It is the knowledge of this infinity which encourages us to believe that we are not beneath His care; and both in the Old and New Testaments we are assured of this. David says, "In Thy book all my members were written." And our Lord, when encouraging His disciples to trust in their Heavenly Father's individual interest in them, told them that the very hairs of their heads were all numbered.

I must say one or two words about a mother's prayers. In my large experience of boys and their home training, I do not remember a single instance of a lad's not turning out well who possessed the inestimable privilege of a prayerful Christian mother, and I have known very many who have grown up to be the pride and comfort of such mothers.

An interesting circumstance connected with a mother's prayers occurred in our school not long ago. One of the junior masters, Mr. Arthur Redman, a thoroughly good fellow, and in every respect a gentleman, was suddenly struck down with a severe cold and inflammation on the lungs. It was midnight; all the family had retired to rest

excepting his ever-watchful and loving mother, who when all was still knelt down and prayed with and for her son. Getting up in his bed he threw his arms around her neck and said, "Oh, darling mother, that is so nice!" He then sank back and not many hours afterwards died, and was wafted to heaven on that mother's loving prayers.

I have referred before to the law of increase called into operation by man; there is a similar law in reference to sincere prayer accompanied with faith. "He that goeth forth and weepeth, bearing precious seed, shall doubtless come again with rejoicing, bringing his sheaves with him." "So shall my word be: it shall not return unto me void."

About the year 1812, two or three young men living at Colchester thought they would try and imitate what Robert Raikes had done in Gloucester, by opening a Sunday school. They hired a room in the town, and invited poor boys to come and learn to read the Scriptures, and soon had a number of lads around them, amongst whom was one who gave them some concern, but yet was a bright, intelligent lad. The time came when it was necessary for him to leave the school, and his good teachers offered up special prayer on his behalf; and one in particular not only asked God to bless him, and to lead him to love Him, but also accompanied him to the door and whispered a text in his ear, hoping that the grain of precious seed might germinate in his heart.

The boy left the town to go to another, and was one Sunday morning strolling through the streets, when seeing a place of worship open, he had the curiosity to go in, and just as he crossed the threshold the minister was uttering the words that his late teacher had whispered in his ear; he was so struck that he listened attentively to the sermon, and the next Sunday went again; he did so on several Sundays following, until the attendance of a lad all alone attracted the notice of some of the good people, and they invited him to a

Sunday school they had formed. He gladly went, and soon he showed so much talent and ability that they appointed him to teach a class; this he did so well that much interest was excited in him, and he having by personal application greatly improved his education, some good men joined together to send him to college. There he made rapid progress in every branch of study, and bade fair to become an eminent man, which anticipations were realised, for when I first knew him he was one of the most popular preachers in London. Here then the one grain of precious seed had not only germinated and taken root, but also had so increased that a harvest of souls was the ultimate result.

The story does not quite end here, for his three sons so distinguished themselves at Cambridge that the eldest became a senior wrangler, the second a sixth wrangler, and the third a second wrangler. All these sons are now occupying eminent positions of usefulness, and will add to the harvest gathered in by their honoured father.

The young man who took such interest in the lad, and who dropped into his ear that tiny seed, afterwards lived to see a Sunday school connected with almost every church and chapel in Essex; and I am proud to say he was my father.* For nearly forty years, I think, he acted as honorary secretary to the Sunday-School Union of that county, and often have I heard him say that this special answer to prayer cheered and encouraged him throughout his life, the latter part of which was devoted to ministerial work, and up to the age of seventy-three he preached three times every Sunday. His wish that he might die in harness was granted him; for going to a distance one bitter winter's evening to preach to some poor people, he took cold, and within a fortnight his spirit had winged its flight to heaven. In his study I found his well-worn Bible open at the

* Rev. John Osborn Kinns.

14th of St. John's Gospel. I felt sure that it was the very last chapter he had read in that book he so much loved, and equally sure was I that the words he had last seen were—"In My Father's house are many mansions." "I go to prepare a place for you."

I think he read to his people the writings of St. John more than any other portion of the Scriptures, for he always delighted in proclaiming God's love, and many times did he call his hearers' attention to the fact that in that beautiful model prayer given us by our Lord He taught us to address God as "Our Father," and therefore encouraged us to approach Him with the confidence of children; and that if the Bible had nothing else in it but this one prayer, its value to us would be inestimable.

Conclusion.

In bringing these chapters now to a close, suffer me to say that I am sure there are many honest, upright, and good men who have difficulties and doubts in reference to the authenticity and inspiration of the Bible: I trust they will not apply to themselves any severe remarks which I may have occasionally used, and which have been only intended for "the godless and profane;" but I would hope that I may have brought forward a few arguments and facts which will remove some of these difficulties from their minds.

Permit me also again to repeat that towards eminent scientific men who differ from me on this subject, and who have delved into the mysteries of Nature and revealed to us its secret laws, I entertain the most profound respect, and feel that we cannot too much appreciate the great good they have done and are doing. May God reward them in this world by enabling them to appreciate not only His wondrous

power, but also His Fatherly care; and may He hereafter still further reward them by taking them to dwell with Himself, where they will have infinitely more opportunities and infinitely more capabilities of studying His glorious works, and eternally enjoy the exploration of that Ocean of Knowledge upon the shores of which even Newton had only gathered a few pebbles.

To the believer may I be allowed to say, that if I have been able to bring forward any facts which have interested him and increased his admiration of our inspired Bible, then indeed shall I feel that I have not undertaken this difficult but delightful task in vain. And if this sacred "Lamp" should henceforth shine upon his path more brightly, how intense will be my happiness and how great my reward!

The Bible is not a dry, severe code of laws, from which one would shrink, but a book filled with poetry, anecdotes and allegories, mingled with historical facts of remarkable accuracy; and from first to last it reveals to us not only the greatness, the power, the majesty, and the glory of our God, but it points out our relationship to Him as children whom He loves and for whom He planned the great scheme of Redemption.

It tells us also of the life and sufferings of our Saviour, the account of which inspires us with the profoundest gratitude for His infinite goodness, and melts us with the revelation of His unbounded love.

Let us imagine ourselves carried back to the night before our Lord's crucifixion, and in an upper room we shall see Jesus with all His disciples around Him. They have nearly finished their last supper; a pensive sadness seems to hang over them, which is increased to intense grief and amazement as our Lord, in sorrowful and troubled tones, foretells to them His denial and betrayal. A slight relief

is experienced as the traitor Judas leaves the room to go about his sad, sad work; and then Christ pours forth all His loving words of advice and exhortation.

He finishes, and for a short time there is a deep and solemn silence; then, a glorious radiance lighting up His holy face, He lifts His eyes to heaven, and for the last time prays with and for His beloved apostles; and as that touchingly beautiful prayer proceeds, and He continues to address His Divine Father, He says—

"*Thy word is truth.*"

Science, with humble reverence, repeats—

"*Thy word is truth.*"

History takes up the refrain, and re-echoes back the sentiment—

"*Thy word is truth.*"

May all mankind, from pole to pole, with one voice also exclaim—

"THY WORD IS TRUTH."

APPENDIX.

DIAMONDS.

Copy, with a few corrections, of an article written by the Author in the "Boys' Newspaper," Nov. 10, 1880. *For much of the information he is indebted to Mr. Streeter.*

AMONGST recent news from the Cape we hear that a diamond weighing 225 carats has been found at the Du Toits Pan mine, and a very fine white stone of 115 carats in Jagersfontein mine, in the Free State.

The lucky finders of these stones are vastly richer than they were a few weeks ago, for if these diamonds be of the best quality they will be worth thousands upon thousands of pounds.

It was only ten years ago that all the world was taken by surprise at hearing that some of these precious stones had been found in our African colony; and this is how it came about. A little boy, the son of a Dutch farmer, of the name of Jacobs, living near Hope Town, had been amusing himself in collecting pebbles. One of these was sufficiently bright to attract the keen eye of his mother, but she regarded it simply as a curious stone, giving it little more than a passing glance, and it was thrown down outside the house. Some time afterwards she mentioned it to a neighbour, who on seeing it offered to buy it. The good woman laughed at the idea of selling a common bright pebble, and at once gave it to him; he intrusted it to a friend, Mr. J. O'Reilly, to find out its value; and Dr. Atherstone, of Graham's Town, was the first to pronounce it a *diamond!* It was then sent to Cape Town and examined by the French consul, who forwarded it to the Paris Exhibition, and it was afterwards purchased by the Governor of the Colony, Sir Philip Wodehouse, for £500.

This discovery of the *first* Cape diamond was soon followed by others, and led to the development of the great diamond fields of South Africa.

The mine of Du Toits Pan (where one of the diamonds had been found) is a celebrated group of dry diggings, and their origin was this. A Dutch boer, who occupied a farm-house in this locality, was surprised to find diamonds actually embedded in the walls of his house, which had been built of mud from a neighbouring pond. This led to the examination of the surrounding soil, where more diamonds were found.

On deepening the diggings diamonds were still brought to light, nor did they cease when the rocky bed was at length reached. Soon the ground was marked out into spaces of about twenty square feet, which were called *claims*. These at first fetched about £50 each, and a short time since one-half of such a claim fetched £50,000. What will they sell at now those large diamonds have been found? especially as it is not the first large one from that district, as the following story will show:—A Mr. Spalding gave, in 1872, £30 for a claim quite outside, and not much thought of, and he handed it over to one Antoine to work in shares, who thought he would try to find a gem, and with a boy set to work. He did not succeed at first, but one day, when he had taken up his pick and was turning the soil, he was suddenly spellbound by the sight of a large stone with the primary aspect of a diamond. For some minutes he could neither speak nor move for fear of dispelling the apparent illusion, but collecting his energies he darted forward and clutched his prize. Even then he did not feel quite safe, and it required a grand effort to reach Mr. Spalding's cart, which had to be called into requisition to carry him home. For two whole days he was unable to eat anything from the intensity of his excitement. The diamond weighed 288$\frac{3}{8}$ carats, being, I believe, the largest yet found in South Africa, and is now called the Stewart Diamond.

This brilliant gem is nothing more than crystallised carbon, or a piece of charcoal in another form. How it has been formed deep in the Earth we cannot quite tell, but from recent experiments it seems that enormous pressure has

been necessary for its crystallisation, which will be one great obstacle to its artificial manufacture. Besides possessing such intense beauty it has many useful properties, of which its hardness is especially one, for there is nothing we know of in Nature that exceeds it.

Doubtless many boys when looking at marvellous imitations of diamonds have wondered how a jeweller could possibly tell the difference. Well, the next hardest substances in Nature are the ruby and the sapphire, and they will scratch everything but a diamond; therefore the jeweller has only to apply the sharp point of a ruby to the spurious brilliant, and it will at once be detected.

Another important quality is the cohesion of its particles, which enables it to be ground to a point almost infinitesimal.

Some time ago Mr. R. J. Farrants presented me with some writing which he had executed on a small piece of glass with a diamond, fixed in a delicate machine, whose point had been ground a *million* times finer than that of a pin. This writing was the Lord's Prayer, and the lines were quite invisible to the naked eye; in fact, the whole of the writing was smaller than the tiniest dot that could be made with the finest pen. If the *whole* of the New Testament were written the same size, it would occupy a less space than that of a small thumb-nail.*

The magnifying power of the microscope necessary to enable us to read this minute writing is so great, that if it were possible to put a small boy under the glass he would look ten times taller than the Monument, and his head would be the size of the dome of St. Paul's.

The value of the diamond depends upon its purity, and increases in geometrical proportion.

* Marvellously small as this writing is, it is colossal compared with what has been done, for Mr. Farrants, when President of the Microscopical Society, stated that the Lord's Prayer had been legibly written in the three hundred and fifty-six thousandth part of an inch: in this specimen the writing is so small that, in similar characters, the whole of the Old and New Testaments together (said to contain 3,566,480 letters) could be written *twenty-two times* in the space of one English square inch.

The general rule is that the value of the first carat must be multiplied by the square of the weight. Thus if a cut diamond of the first water weighing a carat be worth £10, then one weighing five carats *of the same water* would be worth £10 × (5 × 5) or £250; and one weighing ten carats would be worth £10 × (10 × 10) or £1,000; so that the Koh-i-noor (Fig. 93)—weighing now, according to different authorities, from 102¼ to 106$\frac{1}{16}$ carats—would be worth at least

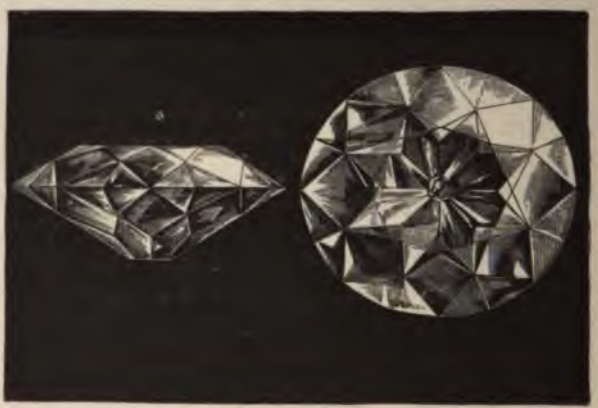

Fig. 93.—The Koh-i-noor, its present size and shape.

£10 × (100 × 100), or £100,000, which is the amount Mr. Streeter values it at.

The story of this valuable stone is very interesting. It has a traditional history in India of about 4,000 years, and can actually be traced back to 56 B.C.

In the fourteenth century it was held by the Rajah of Malwa, and subsequently it fell into the hands of the Sultans of Delhi, after their conquest of Malwa. It remained in the treasury of the Mogul dynasty in Delhi until the wild outbreak of the Tartars, when they passed over the Afghan mountains, and poured in upon the north-west of India. Then Mahommed Shah became the possessor of the jewel. When the conqueror Nadir Shah came to take possession of

Delhi, he ordered Mahommed to give up everything he possessed. He managed, however, to keep back this stone, which he concealed in the folds of his turban; but, unluckily, one of the women of his harem knew the secret, and, alas! he having given her some slight offence, she betrayed him to his enemy. The Shah, however, did not demand the diamond at once, but adopted a novel stratagem to obtain it.

A grand festival was held, at which the two rulers swore love and friendship to each other, and ate and drank together for some hours. At the close of the feast the Shah declared that they must exchange turbans to cement this friendship, and without giving poor Mahommed one moment to consider, snatched off his turban, and exchanged it for his own.

Doubtless Mahommed felt the loss most keenly, but, like a true Oriental, he did not show his vexation by either word or sign. The Persian Nadir carried it away to Corassan, but soon after his death it fell into the hands of the founder of Cabul and his descendants, from whom it was taken by Runget Sing in 1813, who had it set in a bracelet, and after his death it was deposited in the Lahore Treasury. On the annexation of the Punjaub it became the property of the English, and Lord Dalhousie sent two officers in charge of the gem to England, who delivered it to the Queen on the 3rd of June, 1850.

Its weight on arriving here was $186\frac{1}{16}$ carats, but it was so unskilfully cut that it did not look much better than a common crystal. Prince Albert asked the advice of Sir David Brewster as to the best manner of re-cutting it, and its present form of a "brilliant" was finally fixed upon. Eleven Amsterdam workmen were engaged for the operation, which was commenced by his Royal Highness placing it on the mill, driven by an engine of four-horse power, the wheel of which revolved 3,000 times in a minute. By this process of re-cutting and re-polishing it was diminished in size; but its beauty has been so much enhanced that its real value has, I think, been doubled. The "Mountain of Light" is now in the Tower amongst the Crown jewels, and is set in a bracelet which is worn on state occasions by the Queen.

S. K.

THE EARTHQUAKE OF LISBON.

WHILST looking over the proof-sheets of this work, I received from Mr. Bristow a letter, of which the following is a translation; and I think it will interest my readers, not only on account of its being a graphic description of some of the sufferings endured by the citizens on the occasion of that dreadful calamity, but also because the writer was a relative of Mr. Bristow's ancestor.

The letter is from M. A. Girardot to his sister, Madame A. Poupart (of Neuflize), who was sister to Madame André (of London), and to Mrs. Bristow.

BELEM, *January* 27th, 1756.

MY DEAREST SISTER,

I cannot tell you how sensible I have been of the interest that you have taken in my misfortunes, and of your eagerness to show it to me; it affords me on this occasion a very convincing proof of your friendship: be assured that I will never lose the remembrance of it. May the Almighty ever preserve you, my dear sister, from a calamity so terrible, is the prayer that I make to Him at this the beginning of the year, and may He keep for me my parents, who are so affectionate to me and take so much interest in what concerns me.

If I had to depict to you all the circumstances of this sad event, as you ask me, much paper would be needed, and a pen quite different from mine. I will content myself then with telling you, very briefly, what concerns me particularly, and in what manner I escaped the dangers in which so many thousands have lost their lives.

On the eve of that frightful day, whose remembrance makes me still tremble, I had been with a party into the country, where we had danced far into the night. We returned to town very late, and as I was a little fatigued with the gaiety that I had indulged in, I remained in bed the next day a little later than usual. I was still there when I felt myself awakened by a violent shock, and looking

about to discover the cause, I saw the pictures that I had in my room in motion. I understood in a moment what it was : I had already felt, since I was in this country, some tremblings of the earth very like this was at the commencement. At first it was not very great, and I did not think it could last. It ceased indeed, but only to recommence with much more violence after a very short interval. Seized with a terror that I cannot describe to you, I jumped out of my bed, but without knowing what I should do, or how I ought to act in such a terrible situation, on the fourth floor of an extremely high house. The oscillation of my room was so great that I could hardly stand. Seized with giddiness, I made my way to my window, but I was not there long when I saw all the houses which were opposite to me fall down.

I could not doubt that ours would soon follow, and each moment seemed to me the last of my life. I commended myself to God, and had to cling to the window in order not to fall. I hesitated whether I should descend, but it seemed to me, as far as I was then capable of reflection, that it would be much better to fall on the ruins of the house than to be crushed under them. I was in this frightful situation for the space of four or five minutes, after which I felt the trembling diminish gradually, and then cease entirely. I profited by the first moment to hurry below, where I found my companions, who were not yet recovered from their fright. I know not how I recognised them, so much had terror disfigured them ; besides that I could hardly see them through the dust which the fall of the houses had caused.

I tried to persuade them to leave the house and to gain the port as the safest place ; but they only replied to me that the danger had passed, and that I might calm myself ; besides, we were in the safest place in the house, and near a vault under which we could take refuge in case of necessity ; that it was not at all safe to go out of the house. I believed them, and we had not been quiet half an hour when the trembling recommenced ; we ran under the vault, where we remained for the space of a minute, while this second shock lasted, almost as violent as the first. We endured still a third shock about two hours after, but as this last was much weaker than the preceding, it did not frighten us so much. We were commencing to calm ourselves, when one came to

tell us of the overflowing of the river, which had advanced with impetuosity into the town. As a vault could not afford us any refuge against the flood, we determined to go out; and after many dangers which I have not at present time to mention in detail, we gained a ship, where we remained till the evening, when we discovered the town was on fire. Although still very far from us, we were resolved, in spite of our fears, to return there to seize our books and our cash-box; but the earthquake had so deranged the tide that the boats could never reach the land, and we had to return on board until the next day, when we made a fresh attempt, but our house was burned from top to bottom.

This is, my dear sister, all that time allows me to tell you to-day of the circumstances which accompanied this terrible event. I constantly hope that this misfortune will procure me at least the pleasure of seeing you next spring. I have asked for it with importunity; besides the desire so natural to see you all after so terrible a catastrophe, I have such good reasons to wish to make this journey that I hope my dear father and my uncle will not refuse me. To express to you the joy that I shall feel at seeing you again, my good and dear sister, after an absence of eight years, is what I cannot do.

A thousand compliments to my dear brother, to whom I will write next week. My love to the family, and I am, my dear sister, with the most sincere friendship,

A. GIRARDOT.

GLOSSARY OF MINERALOGY.—When speaking of minerals in Chap. III., I have advised my readers to examine the excellent collection of them at the New Natural History Museum, South Kensington. In order, however, thoroughly to appreciate the treasures collected there a short explanation of each is necessary, and I know of no better work for the purpose than Mr. Bristow's "Glossary of Mineralogy."* With this book in your hands, the cases will afford you a rich treat.

* Longmans.

Explosion of Gunpowder.

I received from Major Duncan* the following letter, written to him by Professor Abel, which will give some very valuable information upon this subject.

Woolwich, *December 12th*, 1881.

Dear Major Duncan,

The statement concerning gunpowder should in my opinion stand as follows :—

On explosion gunpowder yields 43 per cent. by weight of permanent gases, and 57 per cent. of matter which is solid at the ordinary temperature, but part of which *may* exist as vapour when powder is exploded under pressure. The permanent gases generated by powder occupy about 280 times the volume of the original powder (at 0° C., and ordinary barometric pressure); but as the temperature of explosion of powder is about 2,200° C. (4,000° Fahr.) these gases exert a tension—when developed in a confined space—which amounts to about 6,400 atmospheres, or 42 tons on the square inch, if the powder *entirely* fills the space in which it is exploded; and the total theoretic work which powder is capable of performing in expanding indefinitely is about 486 foot-tons per pound of powder.

There are no sufficiently authentic data as yet upon which to base such a statement in regard to dynamite as that made. Moreover, dynamite is a somewhat indefinite mixture of nitro-glycerine with an inert absorbent. Any statement eventually made on this must relate to nitro-glycerine and not to dynamite.

Yours sincerely,

F. A. Abel.

Explosion of Gases.—On page 176 there is a reference made to the explosion of a mixture of oxygen and hydrogen gases; it must be remembered that the violent concussion is due to the sudden expansion of the gases, as well as to the rushing of air into the vacuum formed by their after condensation into water.

* Now Lieut.-Colonel Duncan.

THE LENGTH OF DAY AND NIGHT AT THE POLES.

CAPTAIN BEDFORD PIM, R.N., in his "Marine Pocket Case," gives the following interesting facts in reference to the length of day and night at the Poles:—

"On the 16th March the Sun rises, preceded by a long dawn of 47 days, namely, from the 29th January, when the first glimmer of light appears. On the 25th September the Sun sets, and after a twilight of 48 days, namely, on the 13th November, darkness reigns supreme, so far as the Sun is concerned, for 76 days, followed by one long period of light, the Sun remaining above the horizon 194 days. The year, therefore, is thus divided at the Pole:—194 days' Sun; 76 dark; 47 days' dawn; 48 twilight.

"During the 171 days of no Sun there is some little compensation in the shape of the Moon; for 14 days of every lunar month the Moon would have always been above the horizon, rising generally when in her first quarter, and setting in her last quarter.

"The cause of this unequal distribution of light and darkness, and the reason of there being 194 days of Sun to 171 days of no Sun is, that the excess of light over darkness is caused by refraction and the shape of the Earth's orbit. The refraction is increased by cold, the Sun being for *several days* visible in the frigid zones when he is as much as one degree below the horizon."

SIGNS OF THE ZODIAC.—I could not explain all these signs in the text for want of room. THE BULL, I think, signifies the power of the Gospel, that animal being an emblem of strength, as the Assyrian winged-bull shows. THE TWINS may refer to our brotherhood with Christ. THE CRAB, or rather perhaps the Scarabæus, may indicate being firmly held by the Redeemer, as this beetle will grasp its young tenaciously even when surrounded with fire. THE LION treading upon a serpent seems clearly to foreshadow the ultimate millennium triumph, when "The Lion of the tribe of Judah" shall trample sin and Satan under His feet.

THE DISCOVERY OF MATTER EXISTING IN A HIGHLY ATTENUATED CONDITION THROUGHOUT SPACE.

As I have received several letters asking for a further explanation of this subject, I have thought that I could not do better than give a quotation from page 340 of Lardner's "Handbook of Astronomy," edited and revised by Edwin Dunkin, F.R.S., &c., Chief Assistant at the Royal Observatory, Greenwich :—

"A fact altogether anomalous in the motions of the bodies of the solar system, and indicating a consequence of the highest importance, has been disclosed in the observation of the motion of Encke's comet. It has been found that its periodic time, and consequently its mean distance, undergoes a slow, gradual, and apparently regular decrease. The decrease is small, but not at all uncertain. It amounted to a day in about ten revolutions—a quantity which could not by any means be placed to the account either of errors of observation or of calculation, and besides this decrease is incessant, whereas errors would affect the result sometimes one way, sometimes the other. The period of the comet between 1786 and 1795 was $1{,}208\frac{1}{9}$ days, between 1795 and 1805 it was $1{,}207\frac{9}{10}$ days, between 1805 and 1819 it was $1{,}207\frac{4}{10}$ days, and between 1845 and 1855 it had decreased to $1{,}205\frac{1}{4}$ days.

"The magnitude of the orbit thus constantly decreasing (for the cube of its greater axis must decrease in the same proportion as the square of the period), the actual path followed by the comet must be a sort of elliptic spiral, the successive coils of which are very close together, every successive revolution bringing the comet nearer and nearer to the Sun.

"Such a motion could not arise from the disturbing action of the Planets. These forces have been taken strictly into account in the computation of the ephemerides of the comet, and there is still found this residual phenomenon which cannot be placed to their account, but which is exactly the effect that would arise from any physical agency by which the tangential motion of the comet would be feebly but constantly resisted. Such an agency

by diminishing the tangential velocity would give increased efficacy to the solar attraction, and consequently increased curvature to the comet's path; so that after each revolution it would revolve at a less distance from the centre of attraction."

JONAH AND THE WHALE.

THIS subject has been so constantly brought forward upon the freethinkers' platform, that one is surprised they have not been weary of reiterating—that Whales are not inhabitants of the Mediterranean Sea—that they have too small a swallow for a man to pass down—that it would be impossible for any one to be inside the stomach of an animal without being suffocated, and then digested by the gastric fluid.

Whales are certainly not inhabitants of the Mediterranean Sea, nor does the Bible say that they are, for the words דג גָּדוֹל (*dāg gādôl*) in Jonah i. 17 mean a great fish, and ἐν τῇ κοιλίᾳ τοῦ κήτους, translated "in the Whale's belly" in Matthew xii. 40, would have been more correctly rendered "in the belly of a huge fish." As, then, it does not say that it was a Whale, the objection to the smallness of the swallow also falls to the ground.

With regard to suffocation, we know that men have been buried alive when in a trance without life being destroyed, and when in that state they have been conscious of what has been going on around them; what right, then, have we to say that the life of Jonah could not be preserved by the application of some natural law? And if kept alive, then the assumption of his being digested by the gastric juice must also be brushed away, for this fluid is perfectly inoperative upon living matter, otherwise it would dissolve the coatings of the stomach, which it frequently does after death.

Though I do not pretend to explain exactly how the life of Jonah was preserved, I think my readers will see that the objections of sceptics are quite untenable, and that this miracle by no means necessarily involves a violation of natural laws.

THE LEARNING OF MOSES.

ST. STEPHEN, in his remarkable oration before the High Priest, said that "Moses was learned in all the wisdom of the Egyptians;" and, as they are generally thought to have had a considerable amount of scientific knowledge, I am continually asked whether Moses had not acquired from the schools of his period much information in reference to the history of creation. My reply is,

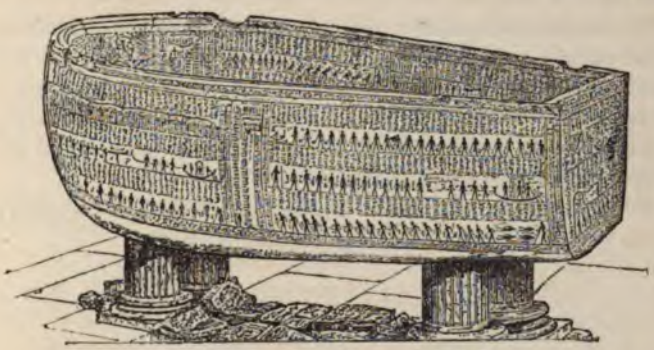

Fig. 94.—Sarcophagus of Seti I.

that the knowledge of science possessed by the Egyptians of that period would not have enabled him to have written a single line of his cosmogony.

Geology was utterly unknown and astronomy so imperfectly studied that for the most part the views then held were in direct opposition to the facts now known to us. Fortunately, the Egyptians were very fond of scribbling over everything, and took particular care to inscribe upon their tombs their opinions upon religion, politics, and science.

Now, we happen to have in Sir John Soane's Museum, Lincoln's Inn Fields, the identical alabaster sarcophagus in which was placed the body of Seti I., the Pharaoh whose daughter rescued Moses from the bulrushes. This sarcophagus is covered with pictures and hieroglyphics inside and out; and amongst other remarkable things, the artist has proved to us that at the

very time Moses was studying in the colleges, it was taught that the Sun went round the Earth; for right round the top of the sarcophagus there is a broad dotted band to represent the *orbit* of the Sun. This, therefore, is conclusive evidence of the fallacious teaching of the Egyptian philosophers in reference to astronomy, and yet you will notice in my early chapters that I show that Moses has given his astronomical facts correctly and in the right sequence.

The accompanying wood-cut (p. 477) is a representation of this sarcophagus, for which I am indebted to Mr. Wild, the curator; and I should advise every one to visit this charming and unique museum.

We are sure that geology was quite unknown to the Egyptians, not only because there is no reference to such a science upon any of their monuments, but also because a very limited knowledge of the rocks could be acquired in any one district—it being necessary to visit all parts of the earth to form a correct estimate of the various strata composing its crust.

There certainly was not a Lyell, a Murchison, a Dawson, a Geikie, or a Bristow in the colleges of ancient Egypt.

EDUCATION OF MOSES.

I HAVE above stated what Moses could not have known of science; I would now notice what he would be taught as the adopted son of Pharaoh's daughter in the time of the Exodus, and I feel that I cannot do better than quote an article written upon this subject by Rev. Canon Rawlinson, Professor of Ancient History in the University of Oxford. In the "Commentary for English Readers," vol. i., page 337, he says that Moses would be educated like the sons of princesses generally, not like those of priests, or of persons destined for literary life; and such education, the Professor says, "would consist, in the first place, of orthography and grammar. Moses would be taught to speak the Egyptian language, and to write it, correctly. He would probably not be taught the hieroglyphic character, the knowledge of which was reserved to the priests, but would be familiarised with the ordinary cursive

writing—the hieratic, as it was called in later times—which was the common character for books, and even for official documents, in his day. Care would be taken to instruct him in the graces of style, so far as they were understood at the time; and he would be especially practised in epistolary correspondence, which was regarded as one of the most necessary of all gentlemanlike accomplishments. Whether his attention would be turned to poetry, might perhaps be doubtful; but he would certainly be taught a clear and perspicuous prose style, such as was required for official reports and other communications between members of the governing class.

"The next branch of his education would be arithmetic and geometry. The Egyptians had made considerable progress in the former, and their calculations ran up to billions. In the latter they are said to have been exact and minute, but not to have pushed their investigations very far. It was sufficient for a youth of the upper classes to be able to keep correct accounts; and a speculative knowledge of the intricacies of numbers, or of geometrical problems, scarcely formed a part of the established curriculum.

"He would be further instructed in morality, and in the Egyptian views on the subjects of the Divine Nature, of the relations subsisting between God and man, of a future life, and of a judgment to come. Egyptian morality was, for the most part, correct so far as it went, and was expressed in terse gnomic phrases, resembling those of the Proverbs of Solomon. The points especially inculcated were obedience to parents and to authorities generally, courtesy to inferiors, and kindness to the poor and the afflicted. The mysteries of religion were the exclusive property of the priests; but life beyond the grave, judgment, reward and punishment, probably metempsychosis, were generally inculcated; and the mystic volume known as the 'Ritual of the Dead' must have been pressed on the attention of all the educated.

"It is not to be supposed that one brought up as the son of a princess would attain to the scientific knowledge possessed by Egyptian professionals of different kinds. Moses would not be an astronomer, nor an engineer, nor a physician, nor a theologian, nor even an historian; but would have that general acquaintance with such subjects which belongs to those who have enjoyed a good general education in a highly civilised community. He

would also, no doubt, have a knowledge of the main principles of Egyptian jurisprudence. But here, again, his knowledge would be general, not close or intimate; and it would be a mistake to expect, in the Mosaical legislation, reproductions, to any extent, or adaptations, of the Egyptian judicial system."

Thus you see the Professor states that Moses would not have been taught astronomy, even if the Egyptians had been learned in that science. We must, therefore, again come to the certain conclusion that his education did not in the slightest degree assist him in reference to the facts stated in his opening chapter of the Pentateuch. I might, perhaps, here call attention to this excellent Commentary, which is edited by the Bishop of Gloucester and Bristol, and all the books are written by men of the highest eminence, amongst whom are the Primate of Australia, the Deans of Canterbury and Wells, Professor Rawlinson, and others.

THE PERMUTATIONS of fifteen things may be further understood by setting down the first fifteen letters of the alphabet something in this way—

g m h d a j k c f e b n i o l,

and challenging any number of persons to try to imitate the order in the list *without seeing it.*

It would be found that if thousands—nay, millions—of people were to attempt to do so, they would fail; in fact, if the whole population of the globe were to endeavour to accomplish this, and each person of the twelve hundred millions were allowed to try a thousand times over, there would still be a great probability that after all those many thousands of millions of trials not one list would correspond in sequence with the unknown order.

How, then, will the sceptic explain the marvellous — nay miraculous!—accuracy in sequence of the Mosaic cosmogony?

LIST OF SIGNATORIES

TO THE

MANIFESTO QUOTED IN THE FIRST CHAPTER.

As I think that the names of all these eminent scientific men should go forth to the world as having declared "that it is impossible for the Word of God as written in the book of Nature, and God's Word written in Holy Scripture, to contradict one another, however much they may appear to differ," I have in this edition given them in full.

Richard Abbatt, F.R.A.S.
G. B. V. Abbott.
John Abercrombie, M.D. Cant., F.R.C.P., Physician to the Cheltenham General Hospital.
Edward Ablett, M.D., M.R.C.S., &c.
Edward Absolom.
Edward Burman Adams, M.R.C.S.E., &c.
Robert Adams, M.A., M.D., F.R.C.S.I., &c., &c., Surgeon in Ordinary to the Queen in Ireland, &c.
Richard Adie, F.C.S.
C. J. B. Aldis, M.A., M.D. Cant., F.R.C.P., &c., Physician to the Metropolitan Free Hospital.
James A. Aldis, B.A.
Robert E. Alison, Royal Woolwich Arsenal.
James Allan, M.A., Ph.D., F.C.S., Professor of Chemistry in the Sheffield School of Practical Science, &c.
R. H. Allnatt, M.A., M.D.
William Alton, M.D., F.R.C.S.I., M.R.C.S., &c.
J. S. Ancona, F.R.A.S., F.R.G.S.
A. D. Anderson, M.D., F.R.C.S., F.F.P.S. Glas., &c. &c.
Thomas Anderson, M.D., F.R.S.E., &c., Professor of Chemistry in the University of Glasgow.

(Rev.) Henry Andrews, C.M.S.
Geo. F. Ansell, Royal Mint.
H. Appleton, M.D., M.R.C.S., &c.
Richard Edward Arden, F.G.S., F.R.G.S., M.R.I.
(Rev.) Thomas Arundel, M.A., F.G.S.
John H. Atherton, F.C.S.
J. C. Atkinson, M.D., M.R.C.S., &c.
Henry Aveling.
(Rev.) John H. Austen, M.A., F.G.S.
Richard Austin, M.D., M.R.C.S., late Professor of Materia Medica in the School of Medicine of the Apothecaries' Society, Ireland.
(Rev.) Henry Hervey Baber, M.A., F.R.S.
William Hellier Baily, F.G.S., F.L.S., Socc. Hist. Nat. Dresdæ et Reg. Leodii. Corresp., Acting Palæontologist to the Geological Survey of Ireland.
William Baker, F.C.S., Assoc. School of Mines, London.
T. B. L. Baker, Esq., F.G.S., F.L.S.
J. H. Balfour, M.A., M.D., F.R.S., Sec. R.S.E., F.L.S., F.R.C.S., Pres. Bot. Soc. Ed., Memb. Acad. Nat. Sci. Philad., Roy. Bot. Soc. Ratis., Soc. Nat. Sci. Cherbourg, Corresp. Memb. Roy. Hort. Soc. Liége, &c. &c., Professor of Medicine and Botany, and Dean of Medical Faculty in the University of Edinburgh.
T. Graham Balfour, M.D., F.R.S., F.R.C.P., L.R.C.S.E., Assoc. Etr. Soc. d'Anthrop. Paris, &c., Deputy Inspector-General of Hospitals.
Thomas Ballance.
Henry K. Bamber, F.C.S.
John Jones Bancroft, F.C.S., &c.
J. T. Banks, B.A., M.D., M.R.I.A. F.K.Q.C.P., Professor of Physics, &c.
S. P. Barchett, Missionary to China.
Thomas Barneby, F.R.A.S.
W. C. Barnes.
W. J. Barnes.
James Barratt, F.C.S.
Arthur H. Bateman.
James Bateman, M.A., F.R.S., F.L.S., F.R.H.S.
(Rev.) J. Chadwick Bates, M.A., F.R.A.S., F.G.S., M.B.M.S.
Thomas Baxter, F.G.S.
Amos Beardsley, F.G.S., F.L.S., &c.
Alexander Beattie, J.P.
J. A. Beaumont, F.G.S., F.R.G.S., J.P., D.L.
(Admiral) A. B. Becher, R.N., F.R.A.S., F.G.S., Hydrog. Office, Admiralty.
John Fritz Beck, B.A.
John Woods Beck, M.D., C.M., L.A.H.S., &c.
Henry Beckett, F.G.S., &c., Professor of Practical Geology.
Saml. H. Beckles, F.R.S., F.G.S.
C. W. Bowdler Bell, B.A., M.B., B.Sc., &c., late Demonstrator of Anatomy in the University of Dublin.
Rev.) David Bell, M.D., C.M., &c.

John P. Bell, M.D., C.M., L.R.C.P.E., &c.

Thomas Bell, F.R.S., F.G.S., late Pres. L.S., Acad. Cæs. Nat. Cur. Soc., Soc. Hist. Nat. et Philom. Paris, Acad. Sc. Philad., Soc. Hist. Nat. Bost. et Lit. et Sc. Hung. Corresp., Professor of Zoology in King's College, London.

William John Belton, Stud. at Roy. Coll. Chem. Lond.

A. Benn, Stud. at Roy. Coll. Chem. Lond.

(Sir) James Risdon Bennett, M.D., F.R.C.P., F.R.G.S., Physician and Lecturer on Clinical Medicine at St. Thomas's Hospital, President of the College of Physicians, &c.

Robt. Bentley, M.R.C.S., F.L.S., &c., Dean of Medical Department, and Professor of Botany in King's College, London, Professor of Materia Medica and Botany to the Pharmaceutical Society, and Professor of Botany in the London Institution, &c.

Capel H. Berger, F.C.S.

(Rev.) Miles Joseph Berkeley, M.A., F.L.S., Acad. Cæs. Nat. Cur. Soc.

Chas. Berrell, Stud. at Roy. Coll. Chem. Lond.

(Rev.) M. S. Berry, B.A.

John P. Bidlake, B.A., F.C.P., F.C.S., &c.

John J. Bigsby, M.D., F.G.S., &c.

C. W. Bingley, Ph.D., F.C.S., &c., Lecturer on Chemistry in the School of Medicine, Sheffield.

Trovey Blackmore, Memb. Ent. Soc.

J. W. F. Blundell, M.D., L.R.C.P.E., &c.

Edward Howard Bolland, M.D., M.R.C.S., &c.

John William Bone, B.A., F.R.G.S.

Francis Bossey, M.D., M.R.C.S., &c.

Joseph Bosworth, D.D., F.R.S., F.S.A., London and Copenhagen, Memb. Roy. Inst. of the Netherlands, Hon. F.R.S. of Sciences, Norway, Ph.D. Leyden, Professor of Anglo-Saxon in the University of Oxford, &c.

(Rev.) W. R. Bowditch, B.A., F.C.S.

J. S. Bowerbank, LL.D., F.R.S., F.L.S., F.G.S., F.R.A.S., &c.

Fred. V. Bowman, F.R.A.S., F.C.S.

Maynard Bowman, B.A., University Laboratory, Glasgow.

Henry Harvey Boxwell, M.D., F.R.C.S.I., Surgeon to the Wexford County Infirmary and Gaol, &c.

C. Lawrence Bradley, F.R.C.S., F.L.S., F.Z.S., &c., Surgeon to the Model Prison, Pentonville.

Benjamin Wellington Bradshaw, M.D., M.R.C.S., &c.

(Sir) Antonio Brady, F.G.S., &c.

(Rev.) George Weare Braikenbridge, M.A., F.L.S.

Robert Braithwaite, M.D., F.L.S., M.R.C.S., &c.

A. Bredon, M.D., M.R.C.S., &c.

(Sir) David Brewster, K.H., LL.D., D.C.L., F.R.S., V.P.R.S.E., Hon. M.R.I.A., et Phil. Soc. Cam., F.G.S., F.R.A.S., M.A., M.D., (Jena), Ord. Boruss. "Pour le Mérite" Eq., Officer of the Legion of Honour, Inst. Imp. Par. (Acad. Sci.) Assoc., Acadd. Sci. Imp. et Reg. Petrop. Berol. Brux. Götting., Hafn. Soc. Bat. Harlem, Holm, Ludg.

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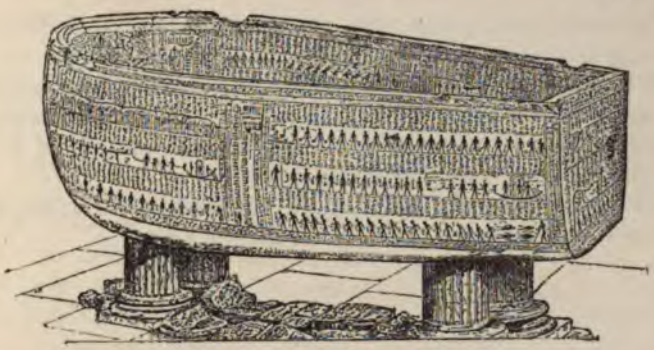

Fig. 94.—Sarcophagus of Seti I.

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EDUCATION OF MOSES.

I HAVE above stated what Moses could not have known of science; I would now notice what he would be taught as the adopted son of Pharaoh's daughter in the time of the Exodus, and I feel that I cannot do better than quote an article written upon this subject by Rev. Canon Rawlinson, Professor of Ancient History in the University of Oxford. In the "Commentary for English Readers," vol. i., page 337, he says that Moses would be educated like the sons of princesses generally, not like those of priests, or of persons destined for literary life; and such education, the Professor says, "would consist, in the first place, of orthography and grammar. Moses would be taught to speak the Egyptian language, and to write it, correctly. He would probably not be taught the hieroglyphic character, the knowledge of which was reserved to the priests, but would be familiarised with the ordinary cursive

writing—the hieratic, as it was called in later times—which was the common character for books, and even for official documents, in his day. Care would be taken to instruct him in the graces of style, so far as they were understood at the time; and he would be especially practised in epistolary correspondence, which was regarded as one of the most necessary of all gentlemanlike accomplishments. Whether his attention would be turned to poetry, might perhaps be doubtful; but he would certainly be taught a clear and perspicuous prose style, such as was required for official reports and other communications between members of the governing class.

"The next branch of his education would be arithmetic and geometry. The Egyptians had made considerable progress in the former, and their calculations ran up to billions. In the latter they are said to have been exact and minute, but not to have pushed their investigations very far. It was sufficient for a youth of the upper classes to be able to keep correct accounts; and a speculative knowledge of the intricacies of numbers, or of geometrical problems, scarcely formed a part of the established curriculum.

"He would be further instructed in morality, and in the Egyptian views on the subjects of the Divine Nature, of the relations subsisting between God and man, of a future life, and of a judgment to come. Egyptian morality was, for the most part, correct so far as it went, and was expressed in terse gnomic phrases, resembling those of the Proverbs of Solomon. The points especially inculcated were obedience to parents and to authorities generally, courtesy to inferiors, and kindness to the poor and the afflicted. The mysteries of religion were the exclusive property of the priests; but life beyond the grave, judgment, reward and punishment, probably metempsychosis, were generally inculcated; and the mystic volume known as the 'Ritual of the Dead' must have been pressed on the attention of all the educated.

"It is not to be supposed that one brought up as the son of a princess would attain to the scientific knowledge possessed by Egyptian professionals of different kinds. Moses would not be an astronomer, nor an engineer, nor a physician, nor a theologian, nor even an historian; but would have that general acquaintance with such subjects which belongs to those who have enjoyed a good general education in a highly civilised community. He

very time Moses was studying in the colleges, it was taught that the Sun went round the Earth; for right round the top of the sarcophagus there is a broad dotted band to represent the *orbit* of the Sun. This, therefore, is conclusive evidence of the fallacious teaching of the Egyptian philosophers in reference to astronomy, and yet you will notice in my early chapters that I show that Moses has given his astronomical facts correctly and in the right sequence.

The accompanying wood-cut (p. 477) is a representation of this sarcophagus, for which I am indebted to Mr. Wild, the curator; and I should advise every one to visit this charming and unique museum.

We are sure that geology was quite unknown to the Egyptians, not only because there is no reference to such a science upon any of their monuments, but also because a very limited knowledge of the rocks could be acquired in any one district—it being necessary to visit all parts of the earth to form a correct estimate of the various strata composing its crust.

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LIST OF SIGNATORIES

TO THE

MANIFESTO QUOTED IN THE FIRST CHAPTER.

As I think that the names of all these eminent scientific men should go forth to the world as having declared "that it is impossible for the Word of God as written in the book of Nature, and God's Word written in Holy Scripture, to contradict one another, however much they may appear to differ," I have in this edition given them in full.

Richard Abbatt, F.R.A.S.
G. B. V. Abbott.
John Abercrombie, M.D. Cant., F.R.C.P., Physician to the Cheltenham General Hospital.
Edward Ablett, M.D., M.R.C.S., &c.
Edward Absolom.
Edward Burman Adams, M.R.C.S.E., &c.
Robert Adams, M.A., M.D., F.R.C.S.I., &c., &c., Surgeon in Ordinary to the Queen in Ireland, &c.
Richard Adie, F.C.S.
C. J. B. Aldis, M.A., M.D. Cant., F.R.C.P., &c., Physician to the Metropolitan Free Hospital.
James A. Aldis, B.A.
Robert E. Alison, Royal Woolwich Arsenal.
James Allan, M.A., Ph.D., F.C.S., Professor of Chemistry in the Sheffield School of Practical Science, &c.
R. H. Allnatt, M.A., M.D.
William Alton, M.D., F.R.C.S.I., M.R.C.S., &c.
J. S. Ancona, F.R.A.S., F.R.G.S.
A. D. Anderson, M.D., F.R.C.S., F.F.P.S. Glas., &c. &c.
Thomas Anderson, M.D., F.R.S.E., &c., Professor of Chemistry in the University of Glasgow.

would also, no doubt, have a knowledge of the main principles of Egyptian jurisprudence. But here, again, his knowledge would be general, not close or intimate; and it would be a mistake to expect, in the Mosaical legislation, reproductions, to any extent, or adaptations, of the Egyptian judicial system."

Thus you see the Professor states that Moses would not have been taught astronomy, even if the Egyptians had been learned in that science. We must, therefore, again come to the certain conclusion that his education did not in the slightest degree assist him in reference to the facts stated in his opening chapter of the Pentateuch. I might, perhaps, here call attention to this excellent Commentary, which is edited by the Bishop of Gloucester and Bristol, and all the books are written by men of the highest eminence, amongst whom are the Primate of Australia, the Deans of Canterbury and Wells, Professor Rawlinson, and others.

THE PERMUTATIONS of fifteen things may be further understood by setting down the first fifteen letters of the alphabet something in this way—

g m h d a j k c f e b n i o l,

and challenging any number of persons to try to imitate the order in the list *without seeing it.*

It would be found that if thousands—nay, millions—of people were to attempt to do so, they would fail; in fact, if the whole population of the globe were to endeavour to accomplish this, and each person of the twelve hundred millions were allowed to try a thousand times over, there would still be a great probability that after all those many thousands of millions of trials not one list would correspond in sequence with the unknown order.

How, then, will the sceptic explain the marvellous — nay miraculous!—accuracy in sequence of the Mosaic cosmogony?

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Robert Adams, M.A., M.D., F.R.C.S.I., &c., &c., Surgeon in Ordinary to the Queen in Ireland, &c.
Richard Adie, F.C.S.
C. J. B. Aldis, M.A., M.D. Cant., F.R.C.P., &c., Physician to the Metropolitan Free Hospital.
James A. Aldis, B.A.
Robert E. Alison, Royal Woolwich Arsenal.
James Allan, M.A., Ph.D., F.C.S., Professor of Chemistry in the Sheffield School of Practical Science, &c.
R. H. Allnatt, M.A., M.D.
William Alton, M.D., F.R.C.S.I., M.R.C.S., &c.
J. S. Ancona, F.R.A.S., F.R.G.S.
A. D. Anderson, M.D., F.R.C.S., F.F.P.S. Glas., &c. &c.
Thomas Anderson, M.D., F.R.S.E., &c., Professor of Chemistry in the University of Glasgow.

Alfred Meadows, M.D., M.R.C.P., M.R.C.S., Assoc. King's Coll., &c.
W. Medland, Stud. at Roy. Coll. Chem. Lond.
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Joseph Milligan, F.G.S., F.L.S., F.R.A.S., &c., late Secretary of the Royal Society of Tasmania.
Edmund J. Mills, B. Sc., F.C.S., Chemical Tutor in the University of Glasgow.
J. Moffat, M.D., F.G.S., F.R.A.S., L.R.C.S.E., Corr. Memb. Epidem. Soc.
Ricardo Molteni, Stud. at Roy. Coll. Chem. Lond.
Alfred Monckton, M.R.C.S., &c.
Stephen Monckton, M.D., M.R.C.S., &c., Physician to the West Kent General Hospital.
George Montgomery, M.D., L.R.C.S.I., &c.
Henry Moon, M.D., M.R.C.P., M.R.C.S., &c., Physician to the Sussex County Hospital.
Charles F. Moore, M.D., L.R.C.S.I., &c., late Medical Superintendent of Middletown Hospital, &c.
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G. Shann, M.D. Cant., F.R.C.P., Physician to the York Dispensary and County Hospital.
Wm. Sharp, M.D., F.R.S., F.G.S., M.R.C.S., &c., late Senior Surgeon to the Bradford Infirmary.
John Shaw, F.G.S., F.L.S., &c.
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J. Spencer Stanhope, F.R.S., Inst. Paris Corresp.
Walter Spencer Stanhope, M.A.
(Rev.) Francis F. Statham, M.A., F.G.S.
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C. H. Stone, M.D.
Fade G. Strangman, Stud. at Roy. Coll. Chem. Lond.
T. Wilson Strangman, Dipl. Agric.
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Francis Sutton, F.C.S.
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John Kenworthy Walker, M.D. Cant., &c., Consulting Physician to the Huddersfield Infirmary.
W. Walker, Government Secretary, British Guiana.
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Charles Waterman, late Stud. at Roy. Coll. Chem. Lond.
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J. Watson, M.D., L.R.C.P.E., M.R.C.S., &c.
Seth B. Watson, M.D. Oxon., Hon. Physician to the Radcliffe Infirmary, Oxford.
W. Spencer Watson, M.B., F.R.C.S., Assoc. King's Coll., &c., Assistant Surgeon at King's College Hospital, &c.
Geo. Waylen, M.R.C.S., J.P., &c.
(Rev.) Thomas William Weare, M.A., F.R.A.S., late Second Master, Westminster School.
(Rev.) Thomas William Webb, M.A., F.R.A.S.
W. H. Webb, Com. R.N.
William Webb, M.D., F.R.C.S., F.R.C.S.E., &c., late Physician to the Stafford Infirmary.
J. H. Webster, B.A., M.D. Cant., Physician to the Northampton Infirmary.
Jas. Whatman, M.A., F.R.S., F.S.A., D.L., J.P., &c.
M. A. Whichelo, Stud. at Roy. Coll. Chem. Lond.
George Whipple, F.C.S.
Henry Whitaker, Stud. Roy. Coll. Chem. Lond.
Henry Campbell White, F.G.S.
James Lambert White, B.A.
Joseph White, M.R.C.S.E., &c., Fell. Stat. Soc., Surgeon to the General Hospital, Nottingham.
Robert White, F.G.S., F.R.G.S.
John Whitfield, F.C.S., M.P.S.

Vincent Whitgreave, L.R.C.P.E., M.R.C.S., &c.
F. Wilbrand, Ph.D.
Ernest Powell Wilkins, F.G.S., L.R.C.P.E., M.R.C.S., &c. &c.
E. Williams, M.D. Cant., Physician to the Colchester Hospital.
David Williams, F.L.S., &c.
Geo. Williams, M.D., M.R.C.S, &c.
William C. Williams, B.D., F.R.A.S.
J. G. Wilson, M.D., F.R.S.E., F.F.P.S., Glas., F.R.C.S.E., &c. &c., Pro
fessor in the Andersonian University, Glasgow.
John Wilson, M.D., F.R.S., F.L.S., Inspector-General of Hospitals, Hon
Physician to the Queen.
John P. Wilson.
(Sir) Th. Sellargon Wilson, Bart., M.A., F.G.S.
John Windsor, F.L.S., F.R.C.S., &c.
T. Vernon Wollaston, M.A., F.L.S., F.C.P.S.
A. A. Wood, Stud. at Roy. Coll. Chem. Lond.
Edward Wood, F.R.S.L., F.G.S., &c.
John Wood, F.R.S., F.R.C.S., &c.
A. J. Woodhouse, M.R.I.
(Rev.) Thomas Woodhouse, M.A.
Chas. Woodward, F.R.S., J.P.
Thos. Woods, M.D., L.R.C.S.I., M.R.C.S., Physician to the Fever Hospital
Parsonstown, &c.
John Wrightson, M R.A.C., F.C.S., Professor of Agriculture in the Royal
Agricultural College, Cirencester.
Jas. Wyatt, F.G.S.
Jonathan Wybrants, M.D., L.R.C.P., F.R.C.S., &c., Coroner for Somerset.
R. H. Wynne, late Stud. at Roy. Coll. Chem. Lond.
James Yates, M.A., F.R.S., F.G.S., F.L.S., &c.
Jas. Yonge, M.D. Oxon., F.R.C.P., late Physician to the Plymouth Dis-
pensary, and Devon and Cornwall Hospitals.

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